Electrical World and Engineer

THE CONSOLIDATION OF "THE ELECTRICAL WORLD" AND "ELECTRICAL ENGINEER."

VOL. XXXVII. NEW YORK, SATURDAY, APRIL 27, 1901. No. 17.

PUBLISHED EVERY SATURDAY BY

ELECTRICAL WORLD AND ENGINEER
(INCORPORATED.)

120 LIBERTY STREET, NEW YORK.

TELEPHONE CALL: 4044 CORTLANDT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

J. M. WAKEMAN, - - - - - - President and General Manager.

CHICAGO OFFICE, - - - - - - - - - - - - 936 Monadnock Block.
PHILADELPHIA OFFICE, - - - - - - - - - - 929 Chestnut Street.

EUROPEAN OFFICE, - - - - - - - - - - - A. C. Shaw, Manager.
Hastings House, Norfolk St., Strand, London, England.

T. C. MARTIN AND W. D. WEAVER, - - - - - - - - - - Editors.
T. R. TALTAVALL, - - - - - - - - - - - - - Associate Editor.

NOTICE TO READERS
WHO ARE NOT SUBSCRIBERS.

The ELECTRICAL WORLD AND ENGINEER is not returnable from the newsdealer. If you desire to purchase the paper from a dealer it will be to your advantage to notify him that you will want it, in order to insure his having a copy for you. If you wish to receive the paper regularly, please send in your subscription so that we can mail it to you direct.

Single copies are 10 cents each. The 52 copies for the entire year cost $3.00 in advance. Please send remittance with your subscription order.

ELECTRICAL WORLD AND ENGINEER.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of the ELECTRICAL WORLD AND ENGINEER on or before MONDAY morning of the week of issue. New advertisements can be received up to 10 A. M. of Tuesday of the week of issue.

The first issue of each month is an export issue, having an extraordinarily large foreign circulation in addition to the regular domestic and foreign circulation of this paper.

TERMS OF SUBSCRIPTION.

United States, Canada or Mexico, - - - - - - - - - - - per year, $3.00
Foreign Countries, within the Postal Union, - - - - - - - - - - - 6.00
Single Copies, - .10

In requesting your address changed give OLD as well as new address.

Copyright, 1901, by Electrical World and Engineer, Incorporated.

Entered as second-class mail matter at the New York Post Office.

NEW YORK, SATURDAY, APRIL 27, 1901.

CONTENTS.

	PAGE
Editorial	663
Bell Telephone Personnel	666
Automobile Club Annual Dinner	666
Mr. Holland on Submarine Boats	666
Great Storm	666
The Engineering Side of Telephone Work on the Pacific Coast	667
Reduction of Arsenic Ores in the Electric Furnace, by Carl Hering	670
An Electro-Chemical Phonograph	672
The Value of Telephone Investments	673
Speed Variations of Engines Direct-Connected to Alternators.—II. By A. H. Kruesi (concluded)	674
Compounding of Alternators by Compensating Exciter, by Ernst J. Berg	676
Electrical Speed Recording Instrument, by Frank B. Rae	678
Notes on the Cooper Hewitt Lamp, by Peter Cooper Hewitt	679
Current News and Notes	681
Digest of Current Electrical Literature	682
N. E. L. A. Convention	686
Storage Battery Plant of the Cleveland & Chagrin Falls Trolley System	686
General Electric Exhibits at the A. I. E. E. Conversazione	688
High-Voltage Testing Sets	690
An Improved Telegraph Teaching Instrument	691
Automobile for the Library of Congress	691
A New Method of Silvering Searchlight Mirrors	691
Improved Electric Signs	692
Electric Stanhope Phaeton	692
Rogers Telegraph Apparatus	692
DEPARTMENTS:	
Financial Intelligence	693
Commercial Intelligence	693
General News	696
Trade Notes	699
Record of Electrical Patents	700

THE HAVOC OF THE STORM.

It looked as though the Middle and Eastern States were escaping with a fairly mild and harmless winter, but the storms of the past week have resulted in the usual floods, stalled trolley systems, steam railroad washouts, and broken telegraph and telephone lines. The telegraph lines have suffered particularly, as any one will bear witness who has tried to communicate East and West this week. The telegraph companies have been prompt in their efforts to repair, but the damage has been too extensive to be dealt with in five minutes, and the result is the whole business of the country has suffered. We know that many veteran telegraph managers do not believe in the feasibility of putting transcontinental lines underground, but it does seem to us that here again ingenuity should find a solution for the problems, including those of expense, clogging "capacity," etc. For example, such plans as those of Dr. Pupin suggest a way out of many serious difficulties, and ought to be tried very thoroughly. The wastefulness of such ruin as these spring snows and floods bring in their destruction of aerial electric circuits is a stimulus to every inventor and engineer in getting underground all the wires that can be put there.

STREET LIGHTING.

A very interesting report on the subject of street lighting has just been issued by the committee on light of the Board of Legislation of Cincinnati. It is a record of visits paid by the board to the cities of St. Louis, Chicago, Milwaukee, Pittsburg, Allegheny, Baltimore, Washington, Philadelphia, New York, Hartford, Boston, etc., and notes their observations on this very important branch of municipal work. There seems to have been some kind of idea of adopting Welsbach incandescents in the streets of Cincinnati, and the committee devoted its energies to finding out whether a change to that form of illumination in the place of electricity would be advisable. Its decision points emphatically against the desirability of any such substitution.

In St. Louis the enclosed arcs are much preferred, and "the general sentiment seems to be that Welsbach street lighting is not a success for the business part of the city." The same results were reported by Mr. Ellicott, city electrician of Chicago, who stated that "where electric lights are used the streets are much better lighted than those on which other illuminants are used; and that the cost of lighting per mile of street per year is about 10 per cent more with gas than with electric arc lamps." From Baltimore the same results were obtained. "Welsbach gas lamps are in Baltimore found to be unsatisfactory for the business section of the city where electric lighting is used exclusively." In Boston it was discovered that "arc lamps are not replaced by Welsbach lamps in any portion of the city but that Welsbach gas lamps are to some extent being replaced by arc lamps." These statements will serve to offset many of the efforts made lately in different parts of the country to crowd out electric lighting by representations that the Welsbach system is more efficient and is worsting its adversary.

The conclusion of the whole matter is that the arc lamp is about as permanent as anything can be in its present function of street lighting, but the report points to the fact that the enclosed arc is preferred to the open, as mitigating the "glare," without diminution of serviceability. The committee, indeed, closes its report by specific recommendations of the enclosed arc above all the other illuminants seen by it in use.

Speed Variations of Direct-Connected Engines.

Mr. Kruesi's article upon this subject shows how complex is the problem of causing two reciprocating engines to run smoothly in unison; in fact, considering the magnitude of the forces which have to be reversed many times a minute in a large reciprocating engine, it is, perhaps, wonderful that they can be made to maintain steady rotation of their flywheels or attached generator armatures as closely as they do in actual practice. This is another reason why electrical engineers look with hope to the advent of the steam turbine which, if successful in other directions, will probably eliminate the difficulty of the pulsation that is occasionally found in the existing reciprocating engine. Considering how successful simple rotary motion is in the operation of the electric generator, it is a pity to have to employ reciprocation in the engine which drives it. We think that the variation of speed and acceleration in engines of the best existing types is, however, often exaggerated, and that difficulties in running large generators in parallel are sometimes attributed to the engine when, in reality, they are due either to other causes of dissymmetry between the units, or to defective governor action.

An Electro-chemical Phonograph.

Some twenty years ago a few inventors worked to produce a telephone, and after many efforts a telephone was developed. After the guiding principles were thoroughly understood by the multitude of electrical workers in general, the difficulty was actually experienced of putting electrical apparatus together so as to avoid making a telephone. There were hot-wire telephones, and electrostatic telephones and chemical telephones. Almost any electric apparatus could be modified into developing some telephonic action.

There has been something similar in the case of the phonograph. Originally, a phonograph was produced at great labor and effort. Now it becomes possible to construct various kinds of phonographs. The latest is an electro-chemical apparatus. Nothing can, perhaps, be imagined less likely to "talk back" than an electroplating vat. Yet Messrs. Nernst and V. Lieben describe a minute electrolytic cell in which voice currents set up minute and imperceptible surface variations on a moving electrode, such as will re-establish current variations in a similar cell and reproduce the vocal sounds. The Poulsen electromagnetic phonograph is another instance of delicate and imperceptible surface variations occurring in a moving band of iron, capable of reacting subsequently upon a telephone circuit, and duplicating the original vocal sound.

It would be of great interest to pursue the inquiry further into the nature of the superficial variations which occur in the electrolytic phonograph. They may be, of course, exceedingly minute, since the rapid vibratory repetition of a very feeble disturbance may eventuate in the production of those feeble vibrations to which human ears are sensitive; but a study of the nature of these delicate superficial changes in the electrode should prove of considerable interest and importance.

Compensated Compounded Alternators

An article this week by Mr. E. J. Berg has special interest in view of the importance of automatically compounded alternators. In the direct-current, constant-potential generator the drop of pressure in the armature is proportional to the current strength delivered at its terminals, and, consequently, it is not a difficult matter to compensate its excitation for variable load. The excitation has to be a certain minimum for rated voltage at no load, and also a certain maximum to maintain the rated voltage at full load. If the number of field turns in the series winding is such that the full-load current will just produce the extra magneto-motive force required at full load, then the compensation will be nearly correct for all lesser loads.

In the case of alternators, however, the matter is much more complex. The drop of pressure in the alternator is indeed proportional to the strength of outgoing current, as before, but since the phase of the current varies with the nature of the load, the effect of this armature drop upon the terminal pressure is markedly affected by the phase of the current delivered, which in its turn is affected by the power factor of the load. Consequently, we have with constant excitation the anomalous conditions: First, that the reduction of pressure at the terminals under load is not proportional to the outgoing current, but increases more rapidly than the current; and, second, that whereas a greater lag of current, accompanying a small power factor, rapidly increases the apparent drop for any given strength of current, a condenser load may actually increase the terminal pressure, or produce a negative apparent drop. Consequently, no method of automatic compounding can be successful which does not take the phase of the outgoing current into account. As a result of this complexity, we find that larger alternators are almost invariably constructed uncompounded, and possessing an apparent drop of from 5 to 10 per cent under full, non-inductive load; while this drop greatly increases with inductive loads. In other words, large alternators have to be regulated by hand for constant pressure under varying load.

The only accurate method of compounding such a machine automatically is, as Mr. Berg shows, to supply to its fields a magnetomotive force which is the vector sum of two components, one representing to scale the normal no-load voltage, and the other representing to phase and scale the drop actually occurring in the armature. The vector sum total magnetomotive force would then produce the proper internal e. m. f. in the armature, from which the actual drop would leave the required terminal e. m. f. constant, under all normal loads, no matter how the current might vary in magnitude or in phase. On the assumption that the flux in the magnetic circuits of the alternator are substantially proportional to the magnetomotive forces, the pressure at the field terminals of the alternator must be a vector sum of a constant pressure and of a variable pressure representing the actual armature drop to scale and phase. If the magnetic circuit is fairly well saturated, then the compensation will be rendered imperfect, but if the vector compensation is correct at full load it is usually not far in error at lesser loads.

Having developed the theory of automatic compensation, the article proceeds to describe the method actually employed in the machine represented. It is not easy to understand from the description just how the compensation is effected in this case, and a clear description of the *modus operandi* would be very interesting. It would appear that the method is an approximate one, and does not aim at accurate compounding. On the other hand, however, according to the numerical results quoted, the terminal voltage of the alternator is kept constant to within a small fraction of one per cent, and this is so nearly accurate as to leave nothing to be desired. The connections seem to show two armatures and two fields in the exciter, one field and one armature being rotated synchronously with the alternator.

Electro-chemistry.

The institution recently in one of our great universities of a department of electro-chemistry brings to mind the neglect to which in the past this branch has been subjected in American technical schools. It is true that electro-chemistry figures as a study in the

courses of perhaps all such schools, but in most cases the instruction appears to be meagre in quantity and antiquated in character. Such indications as may be gathered from college registers denote a lack of recognition of the great revolution operated in the theories and methods of this branch by the Arrhenius-Van't Hoff-Thomsen-Nernst-Ostwald school. Indeed, we know of no English text-book in use which gives any adequate treatment of modern electro-chemistry as established by this school. This conditon is reflected by the absence of English equivalents for many important German electro-chemical terms, as is illustrated from time to time in these columns in articles contributed by writers who have received their instruction in electro-chemistry in Germany. In this country the instruction is evidently largely based upon the theories and methods current a quarter of a century or more ago, and it is high time for measures to be taken to correct this unenviable situation. It may be said that the theories of the continental school are not as yet sufficiently established to replace as a basis for electro-chemical technics those of the Faraday-Berthelot school, and it must be admitted that some of the conceptions are highly transcendental in character. The fact remains, however, that these theories are illuminating as applied to explanation of processes, and have been highly fruitful in practical results. The electro-chemical industry has even now reached enormous proportions in this country, and no field offers a better future than this to the properly equipped technical graduate. As a consequence, any of our larger universities would be amply justified in establishing a chair in electro-chemistry, which might well be filled by an American graduate of a German course, or by a German teacher of note.

The Hewitt Vapor Lamp.

We give in a brief article by Mr. Cooper Hewitt this week curves showing the characteristics of the very brilliant and striking vapor-tube lamps shown by him at the recent Conversazione of the Institute. This exhibit is very noteworthy, both from a theoretical and from a practical standpoint. The use of mercury vapor or kindred substances instead of a solid conductor at incandescence, or a tube of rarified gas under excitation of high-tension electric discharges, leads to a set of curious quasi-conductive properties of a most interesting character. Study of them is likely to lead to results of no little theoretical importance, particularly in view of the fact that mercury has a monatomic molecule and a high atomic weight. Its spectrum, too, bears some curious relationships to those of the other members of its metallic family, and the power of getting from tubes like Mr. Hewitt's a tremendously powerful and very steady light facilitates research into these relationships. If these tubes were merely intended for scientific purposes they would offer a splendid field for investigation into some of the most abstruse problems of molecular dynamics, and we trust that such an opportunity will not pass unutilized. But in this case pure science and applied science join hands, for in these tubes we have seen publicly exhibted for the first time really powerful lights of a type hitherto commercially unutilized, lights of intensity great enough to be taken seriously, and of efficiency undoubtedly much higher than any form of incandescent lamp proposed. A total horizontal intensity of 500 to 1000 candle-power is great enough to compete with ordinary arc lamps, and that it is produced by direct current of voltage such as is ordinarily available, is a strong recommendation from a practical standpoint as against radiants that can only be worked by alternating currents perhaps of transcendental frequency.

But with all these things in its favor it is still a far cry from even the brilliant exhibits of the other evening to a lamp that will meet the every-day requirements of commercial work. No one recognizes this more fully than Mr. Hewitt himself, whose modest notes in this issue are a model of self-restraint that we can commend to inventors in general. The first and most obvious difficulty to be overcome is met in the color of the light, which in its natural state is quite impossible from an artistic standpoint, and in so far as it is due to mercury vapor cannot be really remedied by any conceivable arrangement of shades. For the thing lacking is the red component of ordinary illumination, and there is no process known under heaven among men by which colored shades or screens can put anything into a light which was not there originally. Now, mercury gives a spectrum practically devoid of red lines, and the light from its vapor can therefore never be screened into its proper color-tone except by suppressing most of it. But we cannot believe that the color situation is therefore irremediable. There is a good opportunity, under the conditions of use of these tubes, to add such substances as will provide the red rays which lack. It may be something of a task to find the right corrective, for most obviously it must not interfere chemically with either the glass of the tubes or the mercury or other substances which are concerned in the production of light. This condition, however, seems by no means impossible of fulfillment. It seems to us that this matter of color is all-important, and must be satisfactorily settled before either this or any form of vacuum tube lamp can find a place in practical illumination. Of the efficiency of Mr. Hewitt's tubes there seems to be no reasonable doubt. Of course, the measurements were in cylindrical rather than spherical candle-power, and this fact must be taken into account in comparisons; but discounting this matter one still has an efficiency comparable with the electric arc at its best considerably better than a watt per spherical candle-power.

In fact, Mr. Hewitt's tubes are far more closely comparable to arcs than to any other form of radiants. In characteristics they appear to be substantially arcs in conducting vapor, as contradistinguished from discharges such as are produced in Geissler tubes. So far as appearances go, they give more light and give it more efficiently than arcs in air of the ordinary enclosed type. But we have seen no statements and can form no opinion from the data at hand of the probable amount and rapidity of deterioration. The temperature of the vapor is by no means low and the amount of energy dissipated per tube is about the same as in an arc lamp. Whether it will be easy to get tubes that will stand up under the protracted high temperature without breaking or tending to become opaque, remains to be seen. Aside from this question of life the chief remaining difficulty to be overcome is the very considerable sensitiveness to variations of voltage which is apparent from the curves. This is something akin to that exhibited by Nernst lamps, which have to contend with the same trouble, and in both cases a remedy may reasonably be expected in due season; indeed, Professor Fessenden, in a recent patent, discloses what appears to be a satisfactory solution for this difficulty with respect to the Nernst lamp. High efficiency lamps of any form are plentifully supplied with troubles of their own, and it would be quite too much to expect that one should escape its due share. But the workers in this field deserve every encouragement, for the inefficiency of the common incandescent lamp is a standing reproach to human ingenuity. We believe at least that the beginning of the end is near at hand. Perhaps we may never get light without heat, or even as near an approximation to it as the firefly exhibits for our confusion on summer nights, but there surely is a reasonable chance for a light far better than has yet been reduced to commercial form. Mr. Hewitt is certainly to be congratulated on having obtained the union of two very valuable properties, good intrinsic brilliancy and very great efficiency. We hope that in its further development he will be equally successful in combining these with all the elements of commercial success.

Bell Telephone Personnel.

It was stated in these pages as far back as last February that Mr. F. P. Fish, counsel of the American Bell telephone interests, would succeed the late Mr. Hudson as president of the American Telephone & Telegraph Company. The election of Mr. Fish was only made last week, and the new incumbent will enter upon his duties in July, when the acting president, Mr. Cochrane, gives up the office. The Bell interests are to be congratulated upon their choice, which has required, however, that Mr. Fish should make serious sacrifices in regard to his profession. The fact hardly needs stating that Mr. Fish, by great natural ability, coupled with training and practice of the most severe character, has placed himself at the very front of the patent bar, and has been distinguished by his brilliant association with some of the most notable patent litigations ever fought out in United States courts. With a monumental capacity for work, and a mind of strongly judicial cast, Mr. Fish was bound to go far and high in his profession, had he remained active in it, but like one or two other men of the same stamp, he has now been called to the control of the destinies of a great commercial corporation. It goes without saying that these new duties will require a concentration of effort, and necessitate the relinquishment of other work, such as that he has long done as counsel for the General Electric Company. Indeed, it is hard to picture that company without Mr. Fish prominent in its affairs, and it is no reflection on the directive capacity of President Coffin to say that in the executive as well as the legal aspect of his heavy duties he has long leaned with confidence on the sound advice of his close personal friend, Mr. Fish, throughout a development well-nigh unparalleled in American industrial history.

The other important news in Bell telephone is that Mr. John I. Sabin, whose remarkable work on the Pacific Coast has been made the subject of recent articles in the ELECTRICAL WORLD AND ENGINEER, will be brought to the Central States to repeat his work. It is now announced that Mr. Sabin has been elected president of the Chicago Telephone Company and of the Central Union Telephone Company, and will thus wield the Bell authority in the States of Iowa, Illinois, Indiana and Ohio, excepting Cleveland and Cincinnati at present. It is stated that the Pacific Coast work will be duplicated in these States, where the "Independents" have made enormous headway, and that Mr. C. E. Nestor, who has been at the head of Mr. Sabin's canvassing bureau and more lately of aggressive work for the Erie system, will have in hand the new campaign, upon which it is said some ten millions may be spent for new equipment, etc.

Automobile Club Annual Dinner.

A most successful second annual dinner was given by the Automobile Club of America at the Waldorf-Astoria on April 18. The work of arrangements was in the hands of Mr. J. M. Hill, acting chairman of the House Committee, who is entitled, with Secretary Malcolm M. Ford, to credit for the smoothness with which the affair went off. There were many electrical men present, including T. A. Edison, H. Ward Leonard, A. L. Riker, C. J. Field, W. S. Mallory, W. E. Gilmore, R. E. Dyer, W. Mandelick, H. M. Byllesby, H. McA. Lloyd, H. Sanderson, Isaac L. Rice, J. H. Hoadley, T. J. Ryan.

The dinner was presided over by Mr. A. R. Shattuck, the able president of the club. Lieutenant-General Nelson A. Miles sat on the president's right, and others who occupied places at the guests' table were General Roy Stone, Edward A. Bond, State Engineer; Colonel John Jacob Astor, Dr. H. H. Kane, president of the Road Drivers' Association; A. C. Bostwick, vice-president of the Automobile Club; H. B. Fullerton, of the Long Island Automobile Club; Captain Edgar Jadwin, representing Elihu Root, Secretary of War; D. R. Budd, Commissioner of Roads for New Jersey; Representative J. S. Sherman, Thomas M. Moore, T. C. Martin, toast master, and J. Dunbar Wright.

In responding to the toast of the National Highway Commission General Miles complimented the Automobile Club on the prominent stand it had taken in the cause of good roads. Road improvement, he said, was an evidence of civilization, and in assuming the lead in the movement the automobilists had naturally become leaders in civilization. He pointed out that, though the Romans had built good roads primarily for military purposes, commercial advantages had followed in their train. "If, as has been calculated," he said, "ninety-nine per cent of every load by railroad, steamboat or express must be carried in a wagon or truck over a highway; if the cost of transportation is increased more than three times by bad roads, and the mud fiend swallows up more than $500,000,000 a year, the question of road improvement seems to me to be at one and the same time the plainest and the most important economic problem for this country to consider."

State Engineer Bond, in responding to the toast, "Present Necessities for State Aid in Highway Improvements," predicted that the time was not far distant when there would be a great national highway from Maine to California. He caused much enthusiasm by announcing that a proposition was being considered at Albany to issue State bonds for $5,000,000 to be used toward improving the roads of the State. He stated that last year the amount of appropriations for good roads made by Massachusetts was 80 cents per capita, by Connecticut 77 cents, New Jersey 46 cents, and New York State only 3 3-10 cents per capita. He believed, however, that this State would soon outstrip the others named in this respect.

Speeches in which the good roads idea predominated were made by General Roy Stone, Congressman S. Sherman, M. J. Verdery and M. H. De Young, of the San Francisco *Chronicle*. Dr. H. H. Kane put in a word for the horse that was enthusiastically received. Mr. Verdery defined "Ideal Automobilism" as being "to let the other fellow own it and you ride in it." Mr. H. B. Fullerton also spoke up bravely in behalf of good roads.

The banquet room was most tastefully decorated, and the sorbet boxes were in the form of tiny automobiles. The menus were a very handsome work of art, decorated with what has come to be known as the Automobile Club poster, and with "automobile red" trimmings. The dinner ranks among the best ever served at the Waldorf by Oscar, who was therefore dubbed "autocar" as a fitting acknowledgment for the swiftness of the service.

Mr. Holland on Submarine Boats.

Mr. John P. Holland, the inventor of the submarine torpedo boat bearing his name, proclaimed his view in a lecture at the Carnegie Lyceum in New York City on April 22, that in the course of a few years submarine vessels would supplant surface craft for short journeys by water. Mr. Holland's very interesting lecture was one of a course now being given by the alumni of Manhattan College on scientific subjects for the benefit of that institution. Lewis Nixon introduced the speaker.

Mr. Holland said: "For transatlantic travel submarine boats will never be possible commercially. For short trips the submarine offers commercial advantages that will render it a dangerous rival of the surface-sailing vessel, if, indeed, it does not drive the latter entirely out of competition in certain waters. Take, for example, the trip across the British Channel. No other water journey causes an equal amount of suffering. The most hardened traveler becomes seasick there. Fogs and heavy traffic are constantly causing collisions. Storms toss the smallest boats about like cockleshells. The submarine boat will remove all these objections. There will be no seasickness, because in a submerged boat there is no perceptible motion. There will be no smells to create nausea, for the boats will be propelled by electric power taken from storage batteries. There will be no collisions, because the boats will travel coming and going at different depths, say, one at 40, the other at 60 ft. The water overhead may be crowded with small craft, but the submarine will have a free, unobstructed course. She will be kept absolutely true to this course by means of cables running from shore to shore. On these cables will run automatic steering gear attached to the submarine. Storms and fogs will have no existence for the traveler, for weather has little effect upon the water at the depth at which she moves. The appointments on such a vessel may be finer than anything on the surface. There will be no dampness, no stickiness. The passengers will enter a handsomely fitted cabin at Dover. Electric lights will make it cozy and bright. Neither the cold of Winter nor the extreme heat of summer may be felt. The temperature under water varies but little the year round. Almost without jar the boat will put off from her dock on the English side. Practically no vibration will be felt from the smoothly running machinery. Before the traveler fairly realizes that a start has been made the boat will be fast at her dock at Calais. This is no dream. It is simply the forecast of a trip that I expect to take myself some day."

The Engineering Side of Telephone Work on the Pacific Coast.

A SURVEY was given in these pages last week of the various causes which have contributed to the extremely rapid development of the Pacific States telephone companies under the vigorous management of President Sabin. That article dealt more particularly with the number of subscribers, rates and other social or commercial conditions of interest. We are now able to take up the discussion of the engineering side of the work.

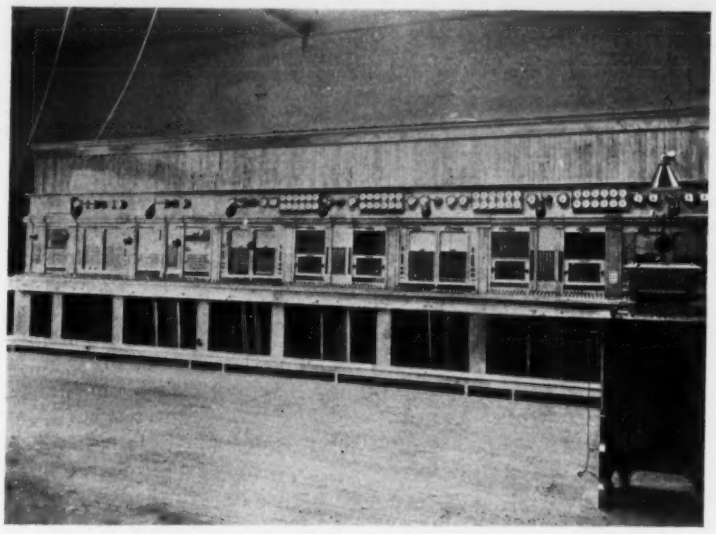


FIG. 1.—PART OF ONE OF FOUR SECTIONS, SAN FRANCISCO.

FIG. 2.—MAIN OPERATING ROOM, SAN FRANCISCO.

EXCHANGE EQUIPMENTS AND OPERATION.

The switchboards and exchange equipments of the Pacific Coast have been developed along radically different lines from the usual Eastern practice, though not wholly unfamiliar there. Instead of a multiple board in which each subscriber's line terminates in a sufficient number of multiple jacks to be within reach of each operator in the exchange, a board is used on which a subscriber's line terminates in front of only two operators. One of these operators is an answering operator designated as an "A" operator. The other operator completes connections and rings only, and is known as a "B" operator. In the earlier types of board the A and B operators were placed side by side. In more recent boards the A boards are placed together on one side of the room and the B boards together on the other side.

The main exchange board at San Francisco (Figs. 1 and 2) is representative of the former type, and the Portland boards (Figs. 3 and 4), indicate the latter. In the San Francisco board it will be noticed that there are two adjoining sections containing drops and answering jacks, then two adjoining sections containing connecting trunk jacks, and so on alternately. With the old type of board, as shown in Figs. 1 and 2, the subscriber's line terminates in only one jack, and that jack is used both by the A operator, who is answering calls and by the B operator beside her who is completing connections. With the new type of board a subscriber's line terminates in front of an A operator, where his calls are answered, and also in front of a B operator on the other side of the room, who connects with him whenever an A operator calls for his number. The latter plan is hence designated as the duplicate jack system. In either case,

FIG. 3.—PORTLAND "A" BOARDS.

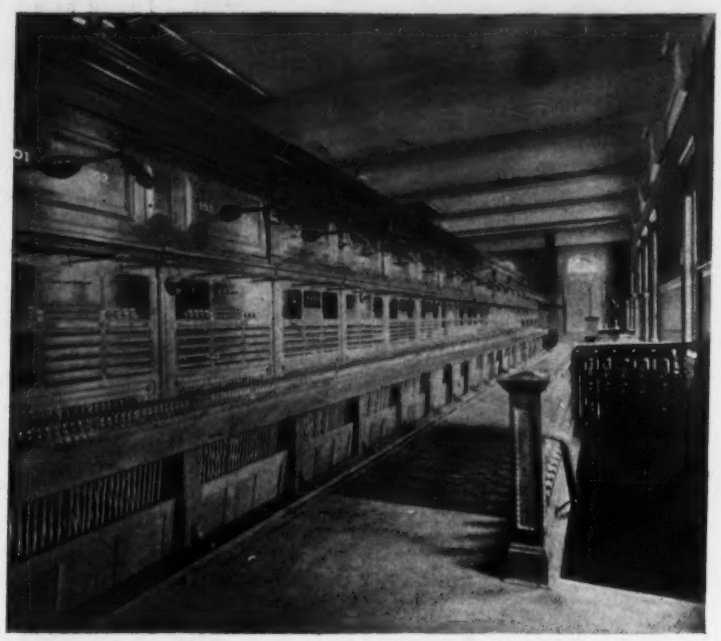


FIG. 4.—"B" BOARD, PORTLAND.

the B operators do nothing but complete connections, and the A operators do nothing but answer calls. In other words, each subscriber's call has to go through the same series of operations as when connection is made between two different exchange offices—that is, connection is completed by means of trunks. Before each B operator is a row of plugs, each one of which is connected to multiple jacks in front of each A operator. When an A operator receives a call for a number she presses the talking circuit button in front of her, which connects with the particular B operator in front of whom the called-for subscriber's jack terminates. She then calls for the number wanted, and the B operator takes up one of the plugs in front of her and connects to the number wanted, at the same time repeating back to the B operator the number and designating the number of the plug with which she has made the connection. This plug being connected to multiple trunk jacks in front of each A operator it is then only necessary for the A operator to connect the calling subscriber to the trunk jack in front of her specified by the B operator and the B operator then presses the ringing key. On the San Francisco Board, shown in Figs. 1 and 2, one or two B operators occupy the space in front of the dorps and answering jacks. The A operators sit in front of the trunk jacks, and in plugging in to answer calls reach over in front of the B operators. When the board is busy there are thus two A operators side by side, then two B operators side by side, and so on. The duplicate jack type of the A board, as shown by Fig. 3, has all the A operators together in front of a board, which contains subscribers' calling signal lamps, and also multiple trunk jacks for connection to the B operators' plugs. The B board (Fig. 4) has simply subscribers' jacks in duplicate with those on the A board and the operators' trunk plugs. The equipment of these latest types of boards will be taken up in detail a little later.

The details of a connection on the old type are as follows for an individual line subscriber: The subscriber's instruments are equipped with a local primary battery—usually a dry cell. The circuits of a subscriber's instrument and switching circuits for an individual board are shown in Fig. 5, which is the diagram for the old type board with A and B operators together. Removing the subscriber's receiver from the hook closes a 30-volt battery circuit through a drop signal or through a relay governing a lamp. The A operator plugs in to answer the call and the insertion of the plug opens the signal circuit to restore the drop or relay. There is also a pilot lamp for each operator on top of the transmitter as long as there is any call unanswered. The A operator having plugged in, uses the listening key to listen in on the board circuit and get the number. She then presses the button which will connect her head telephone on the order line connecting with the B operator before whom the subscriber's jack bearing the desired number is located. Each B operator's head telephone is multiplied on an order button in front of every A operator. When the A operator gives the B operator the number wanted, the B operator notes whether the line is busy, and if it is not she plugs into that subscriber's jack and designates the number of the trunk jack to the A operator. The A operator then completes connection and the B operator rings. On the A board a lamp signifies when the calling subscriber has restored the telephone to the hook. This hanging up of the telephone opens the subscriber's circuit on one side and grounds it on the other. The opening of the circuit closes the lamp circuit through the back point of a relay. In calling a subscriber, the depression of the B operator's ringing key lights a white lamp, which is extinguished by a relay when the subscriber answers. A red lamp lights on the B board

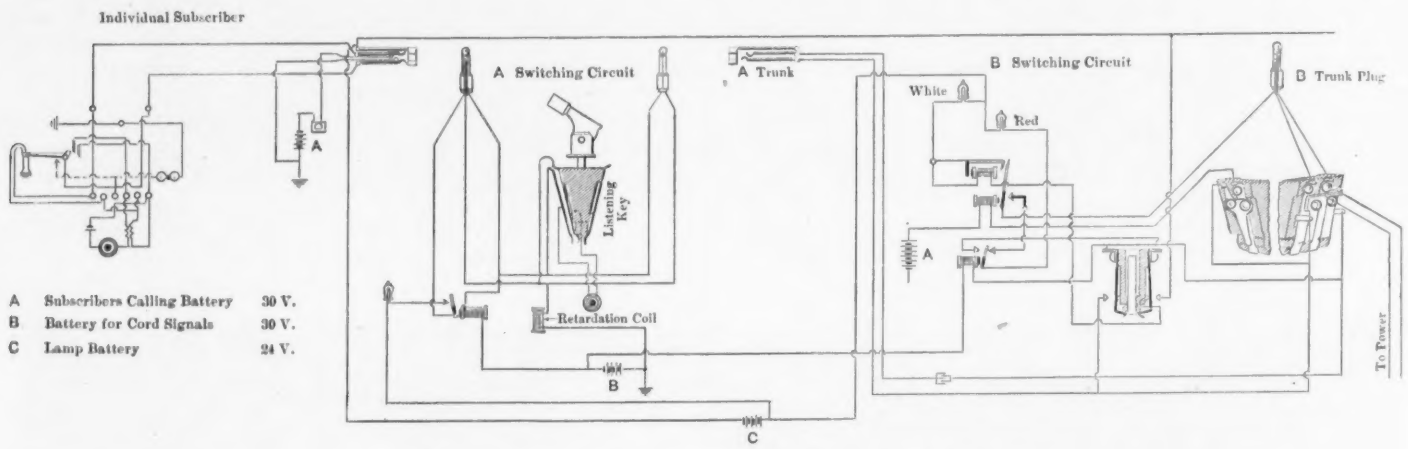


FIG. 5.—DIAGRAM OF SUBSCRIBERS' AND SWITCHING CIRCUITS.

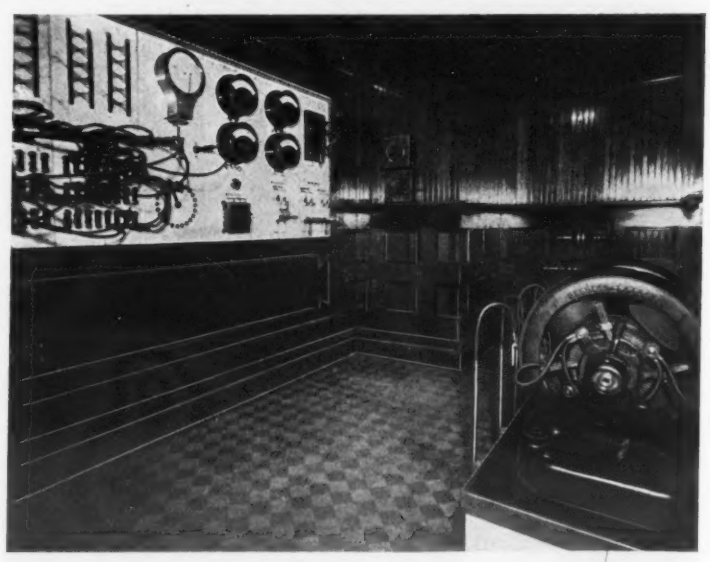


FIG. 6.—POWER ROOM, PORTLAND EXCHANGE.

when the called subscriber returns the telephone to the hook. This will go out when the B operator disconnects, but when the B operator returns the plug to its socket the red lamp will relight if the A operator has not disconnected. This is to prevent her using the trunk again until disconnection from it has been made.

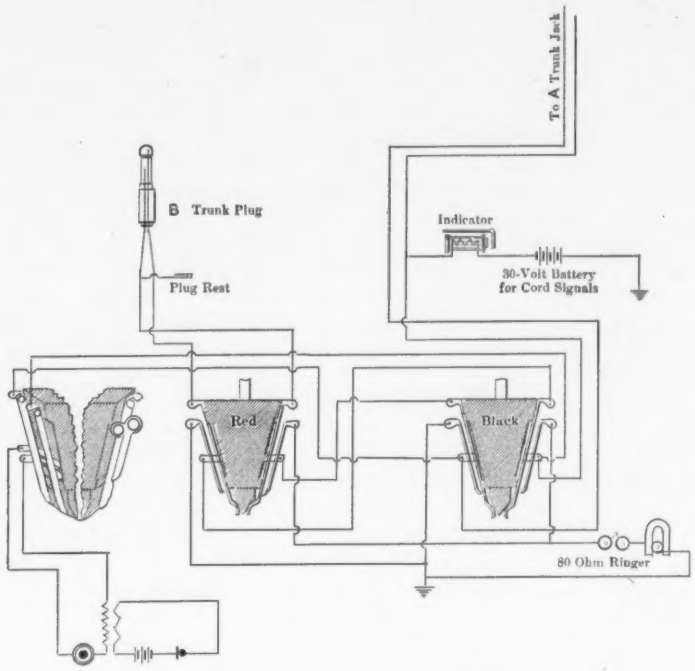


FIG. 7.—DIAGRAM OF PARTY LINE CIRCUITS.

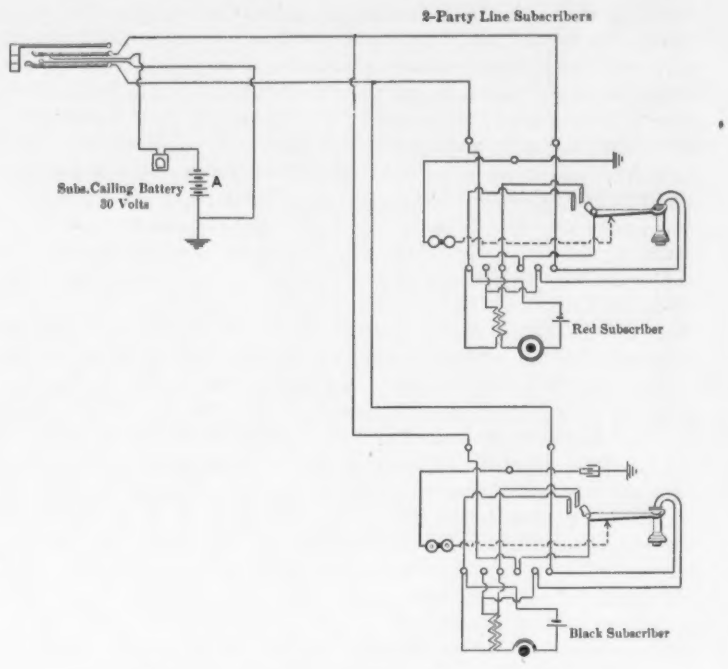


FIG. 8.—DIAGRAM OF TWO-PARTY LINE CIRCUITS.

In the case of a two-party or ten-party line board the general process is much the same, except that when the B operator rings, automatic-counting attachments on the key show which side of the line was rung and the number of bells rung so that she can repeat the call if necessary. Fig. 7 is a diagram of the circuits for a party line B board, and Fig. 8 the circuits of two-party line subscribers' instruments. The ringing is done through condenser to ground on one side, and direct to ground on the instrument on the other side. The signal circuits do not permit of ringing direct to ground on both sides. Ten-party lines are arranged the same way with transmitters bridged across the line and five instruments on each side for ringing.

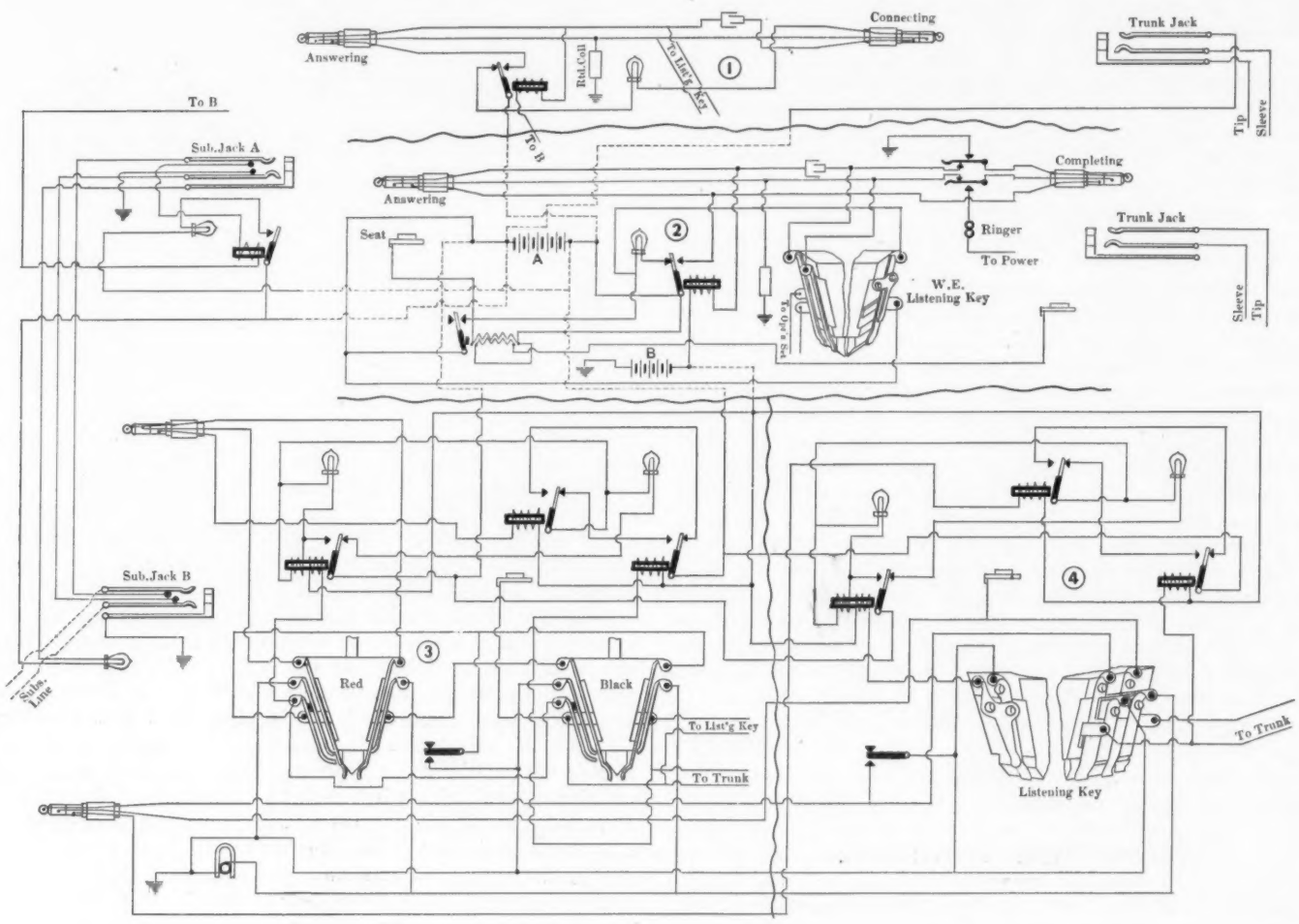


FIG. 9.—DIAGRAM OF SIGNAL CIRCUITS FOR THE DUPLICATE JACK SYSTEM.

Fig. 9 contains the signal circuit diagrams for the latest duplicate jack system in which the section of the diagram marked 1 is A board

switching via trunk; 2 is A board switching via trunk and direct (the latter a plan not much used); 3 is the B board for party lines and 4 is the B board for individual lines. The batteries marked A are 24 volts, and those marked B 30 volts.

Taking up the details of the duplicate jack boards shown in Figs. 3 and 4, as installed at Portland, the A board (Fig. 3) beginning at the top has, first, in the middle panel of each section a row of jacks connected to the monitors and the information bureau. Next below these come the trunk jacks, which are multiplied in each operator's position with the B operator's trunk plugs. Underneath these are the subscribers' lamp signals and answering jacks. Next below the subscribers' answering jacks is a row of clearing-out lamp signals in the cord circuits. Then beginning on the horizontal part of the board are the plugs. A different color of cord is used for each pair of plugs. Next to the row of plugs is the row of talking and listening-in keys for the cord circuits. In the middle of the keyboard is a lamp signal which indicates to the operator when the party calling on a nickel-in-the-slot instrument has deposited the nickel. Nearest to the operator is the double row of pushes for the order wires to the B operators. The B operator's board (Fig. 4) has in the center panel of each section at the top a row of emergency trunk jacks for use when the regular trunks connected to the plugs are busy. Then come the regular subscribers' jacks in duplicate with those on the A board. On the horizontal part of the board are the numbered plugs connected with the trunk jacks on the A boards and plugs for connecting to the emergency trunks. Next to the plugs in the middle are a row of listening-in keys for the cord circuits for the emergency trunks, and in each side are the listening-in keys on the regular trunk circuits. In a row next to these are the lamps which indicate when the subscriber called for answers, and in the next row are the clearing-out lamps. The ringing keys occupy the position next to the operator. If the board is for individual line subscribers, the keys are the usual simple W. E. ringing key; but if it is a party line board, the ringing keys are provided with cyclometer counter attachments which indicate which side of the line was rung and how many rings were given. Each ringing key has a red push for one side of the line and a black push for the other, and is provided with a key for resetting the counter.

Much can be said both for and against the Pacific States switchboards as against the multiple boards so popular in the East. Their chief disadvantage is that the time consumed in making connections between subscribers whose lines terminate in the same office is as great as between two subscribers whose lines terminate in different exchange offices. That is, the connections must all be made via trunk instead of direct by the same operator. The advocates of the Pacific States type of board, however, claim that as long as a large per cent of the calls in any large city have to be trunked anyway, and are not between subscribers whose lines terminate in the same office, it is useless to go to the expense of a multiple board for the sake of avoiding connections via trunk for the small per cent of calls that are for subscribers on the same office. They furthermore claim that by giving subscribers on the same office quicker connections between themselves than between subscribers on different offices a certain precedent in quick switching is established which is likely to give rise to complaints when subscribers on different offices have to wait longer for connections. With the Pacific States board all switches have to go through the same operation, so the time is uniform. Attention is also called to the fact of the ease with which extensions to a board can be made without disturbing the rest of the board and without increasing the investment in switchboard per subscriber. These arguments certainly bear much weight, especially where the growth is as rapid as in San Francisco and other Pacific Coast cities.

The chief advantage of the new duplicate jack boards over the old type boards in which A and B operators were side by side is that when the B operators are together they can help each other and B operators can be grouped on busy portions of the board.

Electric Rights in California.

A new California law makes it a misdemeanor to unlawfully connect with any electric apparatus or wire operated by another, without his consent, for the purpose of appropriating current for light, power, heat or other use. Another law gives cities and towns in California the right to acquire or construct and operate street railways, telephone and telegraph lines, gas and other works for light and heat.

Reduction of Arsenic Ores in the Electric Furnace.

BY CARL HERING.

ARSENIC ores are not mined in this country to any great extent, notwithstanding that rich ores exist in large quantities, even in the East where transportation facilities are favorable. This is all the more noteworthy on account of the high gold values of many of these ores, besides the large amounts of the arsenic. Gold bearing "mispickel" ores are abundant in North America, but they have been neglected on account of the metallurgical difficulties involved in the extraction of the arsenic, or even in getting rid of the arsenic in order to be able to extract the gold and other noble metals, as the presence of the arsenic interferes with the extraction of the other metals. In some cases, as in Butte, Mont., where copper ores containing arsenic are smelted, the arsenic is made to pass off through the chimney of the furnace in the form of the poisonous oxide, which settles over the surrounding country to the great detriment of the neighboring inhabitants.

Mispickel ores occur in the White Mountain section of New England, and are found as far south as North Carolina. Deposits are also found in South Dakota, Washington and California. Very large deposits exist in British North America, particularly in Ontario, but the ore has been mined only to a very limited extent. In British Columbia, they are found more particularly in the Rossland district. Mr. Westman recently made the original blastings in some of the great ore deposits of Ontario which were subsequently examined by the Government geologist and reported upon very favorably in the official report of the Canadian Bureau of Mines for 1900.

According to some advance estimated figures from *The Mineral Industry* the total output of arsenic in 1900 was about 7300 metric tons, made by the following countries: Great Britain, Germany, Italy, Spain and Canada, the first two producing nearly the entire amount. The output was little if any in excess of the consumption. The imports in the United States may be taken at about 10,000,000 lbs. There was no arsenic produced from ores in this country last year.

Notwithstanding the large deposits of rich arsenic ores in this country, nearly all of the arsenic consumed here is imported from abroad. A description of an electrical process, of which the writer was recently called upon to make a quantitative test, and which overcomes the objections to the usual metallurgical processes, enabling the arsenic to be extracted as a metal, and leaving the other metals concentrated in the resulting matte, may therefore be of interest. It is another one of those many instances in which electricity enables a difficult and tedious metallurgical process to be carried out so much cheaper and more satisfactory that ores heretofore unused have become valuable.

The process is applicable to mispickel or arsenopyrite ores, which contain the arsenic in the form of the sulph-arsenide of iron, or in chemical symbols $FeS_2 + FeAs_2$. The ore itself, when freed from all foreign matter, contains 46 per cent by weight of arsenic, and is therefore a very rich ore of that metal. In theory the process consists simply in heating this ore in a closed furnace in an atmosphere free from oxygen. The iron then combines with the sulphur, forming the easily fusible sulphide of iron, or ferrous sulphide, FeS, and setting free the arsenic as a heavy metallic vapor, which is then collected outside of the furnace in condensers, as a very fine metallic powder. The gold, silver and other valuable metals are left in the fused matte which remains, and as it is free from arsenic it can be worked for those metals. Moreover, as the arsenic forms about half of the original material, the amount of the precious metals per ton of the resulting matte is about double what it was in the concentrated ore, and it thus becomes much more profitable as a gold or silver ore.

In practice this process is carried out by passing an alternating electric current through a horizontal column of the matte, which is sufficiently conducting when cold, to enable a great enough current to pass for melting it, and when fused it conducts quite well. The granulated ore is then fed into the top of this fused matte. The furnace is therefore of the resistance type and not of the arc type. It is closed, so as to keep out the oxygen of the air, which in contact with the hot vapor of arsenic would form the very poisonous white oxide of arsenic of commerce, sometimes known as arsenious acid. The ore is fed into the furnace through hoppers which admit no air. It enters in a granulated form into which it is first ground, and then concentrated by pneumatic means to free it as much as possible from the rock or gangue. The vapors are carried off by means of a current

of nitrogen which circulates continuously through the furnace and the condensing chamber, and is produced at the start from ordinary air from which the oxygen is extracted by a small quantity of the vapor of arsenic, forming the oxide. After starting the same nitrogen is used over and over again.

An idea of the furnace may be obtained from the accompanying diagram (Fig. 1). The two electrodes are shown in section at the ends of the column of ore and matte in the closed furnace, with the

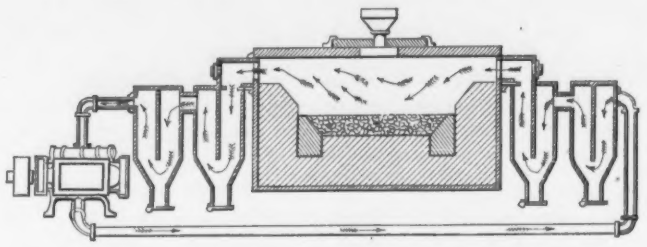


FIG. 1.—LONGITUDINAL SECTION OF FURNACE.

hopper at the top. On each side is a pair of condensers for the vapors, the nitrogen being circulated by means of a reversible blower. The object of reversing the current of nitrogen is to utilize the well-known heat regeneration principle. When one condenser has become hot from the gases, the current of nitrogen is reversed, thus enabling the condenser to give off this heat to the cool nitrogen before it enters the furnace, thereby preventing it from chilling the furnace, and enabling much of the heat carried off by the gases to be recovered. The pulverized arsenic is removed from the bottom of the condensers through suitable traps.

Fig. 2 shows the outside of the experimental furnace with which the writer's tests were made. It is built of firebrick encased in boiler

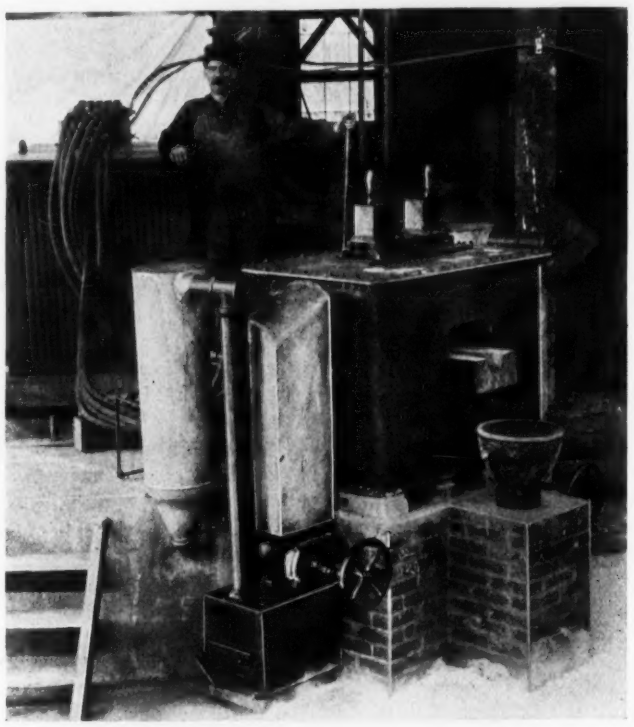


FIG. 2.—VIEW OF EXPERIMENTAL FURNACE.

iron. The electrodes enter from the rear. They are cast iron, which is said to stand the action of the fused ore quite well, and may be renewed at small cost. The tap for drawing off the fused matte is seen in front, and the transformer in the rear. This furnace was built for testing and demonstrating the process, and in general for experimental purposes. For these reasons, and its rather small size, it was not as efficient in energy consumption per ton of arsenic as a larger one constructed for economy would be; but by measuring some of the avoidable losses and calculating others, a very fair estimate was obtained for the energy per ton which would be required in a well constructed furnace, operating on a large scale and continuously.

The measurements and calculations of these losses were somewhat involved. For instance, the alternating current of 8000 to 10,000 amperes at a frequency of 120 passed through rather long, solid, cast iron electrodes, about 6 inches square in section, which involved very large losses by skin effect, resistance, hysteresis, Foucault currents and conduction of heat from the furnace. The losses amounted to more than half of the energy in the secondary circuit of the transformer. The losses in the leads alone from the transformer to the furnace were found to be about 44 kilowatts and 9 to 10 kilowatts were led off as heat by the electrodes, besides many kilowatts lost by Foucault currents and hysteresis. The unavoidable losses in a well constructed furnace had to be considered also. To lead such large alternating currents into a furnace is no simple matter. The conductors must necessarily be large to reduce their resistance and they will then conduct off considerable heat.

In one of the runs the ore was fed at the rate of 185 lbs. per hour, and the power consumed in the furnace was about 105 kilowatts, the current varying from about 4000 to 8400 amperes, and the voltage from about 22 to 12. This is at the rate of about 1140 kilowatt-hours per 2000-lb. ton of ore. This could no doubt be reduced considerably in a large furnace constructed for economy. It is, in the opinion of the writer, quite safe to say that in a well designed and large furnace the power required at the engine shaft will not be more than 1000 kilowatt-hours (about 1350 horse-power-hours) per ton of 2000 lbs. of the ore, such as was used in the test. It may even be considerably less.

Unfortunately no data seems to exist concerning the heat of combination of both of the compounds involved in this process, nor for the specific heats at such high temperature, nor the latent heat of vaporization of the arsenic, and it is therefore not possible to make any definite calculations of the amount of heat required theoretically to bring about this reaction. It has been variously estimated to be from 200 to 400 kilowatt-hours per short ton. If these estimates are correct there is still left a large margin for improvement.

At $20 per kilowatt per year, which is about the cost at Niagara Falls, and a recovery of 90 per cent of the arsenic, the cost of the power per pound of arsenic is about one-quarter of a cent. Metallic arsenic is worth about 6 cents per pound, and the white oxide called arsenious acid 4 to 5 cents. The output of such a furnace is so great that a few of them of fairly good size, would supply the world's consumption of arsenic, but there is little doubt that metallic arsenic could be used for many more purposes than at present.

After freeing these ores from the arsenic the resulting matte becomes in many cases a valuable gold ore, and as it is then reduced to nearly half its bulk it contains nearly twice as much gold per ton. At first the process will be applied only to gold-bearing mispickel ores, but the fact that many of these ores contain large percentages of nickel and cobalt, greatly extends the field of its application.

The action in the furnace is based on an ore having the composition of mispickel, which contains just the right amounts of iron and sulphur to form the easily fusible ferrous sulphide. It contains 46 per cent of arsenic. If the ores also contain the mineral leucopyrite which has 64.1 per cent of arsenic, or loellingite which contains 72.8 per cent of arsenic, some iron sulphide is added in order to free all the arsenic and make the matte a simple iron sulphuret.

Mr. Gustaf M. Westman, of New York, who is the inventor of this process, has been experimenting with it for some time, and is now about to apply it to the large, rich deposits of mispickel ore of the Big Dan claim in Ontario, recently acquired by the owners of the process, the Arsenical Ore Reduction Company, of Newark, N. J., the ores of which, according to the recent official report of the Bureau of Mines, of Ontario, run from $1 to $31.20 in gold and silver, averaging about $5.75. There is a large waterfall near the mine from which cheap power is to be obtained, thereby saving the cost of transporting the ore. It seems probable therefore that the production of arsenic will be transferred to this country by means of the electric furnace.

A study of the losses in the small furnace with which the experiments were made leads to some conclusions which may be of interest to those designing resistance furnaces for other purposes. Most of the losses point to the importance of using continuous currents if possible, as it is more difficult to lead such very large alternating currents through conductors. When, however, alternating currents must be used to avoid electrolysis, as is often the case, then many difficulties are reduced by proportioning the furnace so that the current is as small as possible and the voltage as great as possible; that is, the resistance column of the material should be made as long and as small in cross-section as the circumstances permit. The loop formed by the alternating-current circuit should have as small an

area as possible so as to diminish the induction. The leads should, of course, be made as short as possible, every inch saved in length being important. The transformer should be placed within as few inches of the furnace as possible. Those parts of the conductors which are unavoidable, as, for instance, where they pass through the walls of the furnace, should be made of insulated laminations alternately of opposite polarity, otherwise the skin effect and the inductive effects will become important. For these parts the best electrically conducting material should be used so as to reduce the cross section as much as possible, as such large pieces of metal conduct considerable heat away from the interior of the furnace. The frequency should also be made as low as possible when such very large conductors have to be used. Metallic casings of the furnace should be avoided, particularly of iron. If bands are necessary they should be made of a non-conducting material or have insulated joints in them to prevent closed circuits in the neighborhood of the large alternating field necessarily produced in the part of the circuit in the furnace itself. These are some of the considerations underlying the design of large alternating-current resistance furnaces.

The heat led off through the walls of the furnace, which was about 3-ft. cube, amounted to about 5 kilowatts, the inner temperature being about 1000 to 1200 degs. C., that necessary for the vaporization of the arsenic being only 450 degs. C. The channel for the liquid matte was about 20 inches long and 4 inches wide. This loss, which is not large for a furnace of about 150 horse-power, could be diminished only by having thicker walls, but it becomes relatively less the larger the furnace. Theoretically, the following relations can be shown to exist for different sizes of furnaces, the assumption, for enabling a general law to be stated, being that the furnace is a hollow sphere, with relatively thick walls, and that the temperature of the outside surface remains the same. The capacity (or interior volume) increases as the cube of the inner diameter. The thickness of the walls will increase with the square root of this diameter, and the radiation loss per unit volume of the capacity or interior space will diminish in inverse proportion to the square of the diameter. That is, for twice the inside diameter the capacity becomes 8 times as great, the walls 1.4 times as thick, and the radiation loss per unit volume of the inside becomes only one-quarter as great, showing the great advantage of larger furnaces in diminishing this loss. For rectangular furnaces, especially if quite long, these relations will not be quite as favorable, and these general laws then apply only approximately.

Heating the material quickly, that is, making each particle pass through the process as quickly as is consistent with the proper operation, will, of course, reduce the size of the furnace for the same output, but assuming that a certain definite number of heat units are required per ton of material, as is generally the case, the larger furnace would require the smaller current. Both should, therefore, be considered in designing a furnace.

In all electric furnaces the firebrick lining, when very hot, becomes a conductor, a quality which is made use of in the Nernst lamp. In resistance furnaces this should be taken into consideration, as it lowers the resistances between the electrodes and necessitates a greater current at a lower voltage to produce the same heating effect. This means that greater flexibility in the regulating apparatus is required. The heat generated in this lining is not lost, except in so far as it diminishes the thickness of the heat-insulating walls of the furnace. The conducting of the lining can be prevented only by keeping it cool, which is wasteful.

The Independent Telephone Convention.

Judge J. M. Thomas, president of the Independent Telephone Association of the United States of America, writes us from Cleveland as follows: "We have just determined to hold the fifth annual convention of the Independent Telephone Association of the United States of America at the Pan-American Exposition grounds, city of Buffalo, June 11, 12 and 13. The programme for the meeting will be arranged later. Arrangements have been made by the Pan-American Exposition with all the railroads to carry visitors at one and one-third fare for round trip. The committee on arrangements is composed of Samuel E. Wayland, Scranton, Pa.; Robert R. Hefford and Clark L. Ingham, both of Buffalo, who will arrange for special rates at hotels for those attending the convention."

An Electrochemical Phonograph.

THE sound-recording devices now in commercial use have in common this radical defect: The mechanical operation of making the record is performed by a stylus carried by the vibrating disk, and hence this work is performed directly by the sound waves. It is sufficiently obvious that whether this work consist in indenting or cutting a yielding surface, or in tracing therein an undulating line of even depth, a record so made cannot conform absolutely to the impressed vibrations, but that all vibrations representing less energy than that required for forming the plastic surface must be lost and all others must be modified to some extent. It results from this that record and reproduction of human speech, the vibrations corresponding to which are exceedingly intricate, must fail of exactness.

The Poulsen electromagnetic phonograph announced last year relieves the vibrating disk to a great extent of this work, and according to published reports attains a corresponding fulness and exactness of reproduction and freedom from extraneous sounds. For the plastic surfaces of the earlier types of phonograph, this device substitutes a steel wire moving through the field of an electromagnet excited by the microphone currents, and the varying magnetic effects produced by these currents in successive portions of the wire constitute a record of the currents and hence of the disk vibrations.

In the *Zeitschrift fur Elektrochemie* for April 4, 1901, Nernst and V. Lieben describe experiments illustrating a principle of sound reproduction which represents as radical a departure from commercial types as does the Poulsen device, and which resembles the latter in that the record is only indirectly produced by the movements of the microphone disk. The general principle of this new phonograph is exceedingly simple: Two electrodes, the one movable and the other stationary, are in contact with an electrolyte which is traversed by a fluctuating current, produced by the superposition of microphone currents upon a direct current. Upon the surface of the moving electrode changes occur, the precise nature of which has not yet been determined, but which follow the fluctuations of the current, and which possess some degree of permanence, so that if the electrode be again moved through the bath and a current passed, this current also will fluctuate in accordance with the local surface conditions of the moving electrode, and these fluctuations may be employed to reproduce, in a telephone, the original sounds.

Two devices for carrying this principle into effect are diagrammatically illustrated in the figures reproduced herewith. In the construction shown in Fig. 1, *A* is a storage battery of 10 volts; *M* a

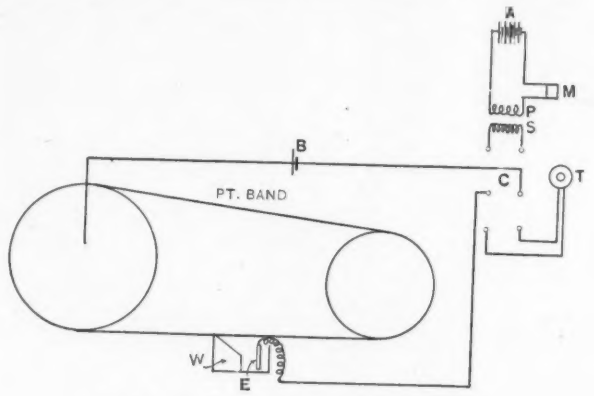


FIG. 1.—ELECTROCHEMICAL PHONOGRAPH.

microphone; *P* the primary and *S* the secondary of a transformer; *C* a switch; *T* a telephone, and *W* wooden wedge, bearing on periphery of a platinum board; *E* is the electrode, and *B* a battery employed for reproduction. A platinum band constituting the moving electrode passes over two pulleys, and at one point moves in light contact with the wooden wedge, saturated with and partially immersed in a suitable electrolyte. Adjacent to this wedge and contained within the same vessel is a second electrode, and the circuit including the two electrodes and the electrolyte is closed through the secondary coil of a transformer, through the primary of which passes the variable current caused by the superposition of the microphone currents upon the direct current from five accumulators. The traveling band registers the fluctuations of the current, and if subsequently a current from a second and lower source of e. m. f. be passed through the band and electrolytic cell and through a tele-

phone included in the circuit, this current fluctuates in such manner as to reproduce in the telephone, with more or less disturbances, the impressed sounds.

Fig. 2 corresponds precisely to Fig. 1, except that a stiff copper disk is substituted for the plantium band, and the battery employed for reproduction is connected in the circuit through a variable resistance, whereby compensation may be made for the varying resistance of the electrolytic cell under different conditions. In this form the periphery of the revolving disk constitutes the record. It is necessary in order to avoid extraneous sounds due to the crystallization of the electrolyte upon the recording surface, that a pad of blotting paper, moistened with the electrolyte be gently pressed against the periphery. In Fig. 2 *R* is a sliding resistance for bringing the galvanometer *G* to zero.

A second paper by V. Lieben, dealing with the form of device represented by Fig. 2, details the results obtained under many dif-

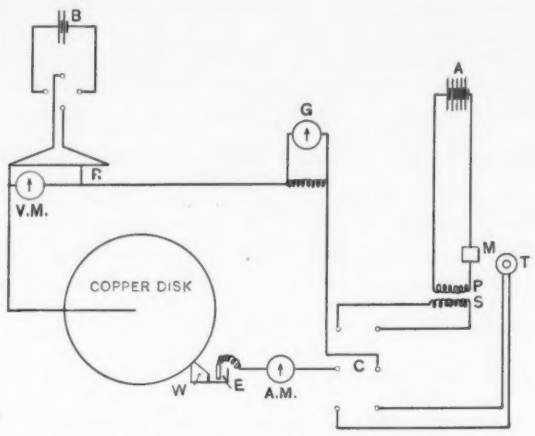


FIG. 2.—ELECTROCHEMICAL PHONOGRAPH.

ferent conditions as regards electrode materials and electrolyte. The best results noted are:

1. With a copper anode in the electrolytic cell the periphery of the copper disk constituting the cathode, and an electrolyte of thrice normal zinc sulphate solution rendered alkaline by potassium hydrate, a current of 4 volts being employed both for record and reproduction. Under these conditions the reproduction was very loud and clear, often repeated 200 to 300 times without marked diminution.

2. Anode, zinc; cathode, copper periphery; electrolyte, potassium zincate solution. Reproduction loud and clear, and capable of some hundreds of repetitions.

3. Anode, silver; cathode, silvered copper periphery; electrolyte, double cyanide of silver and potassium. Reproduction less loud than in the preceding case, but very clear, and permitting some hundreds of reproductions. The original record may be made without the use of an external source of current.

Concerning the nature of the alteration undergone by the moving electrode, the authors consider several possible explanations. The fluctuations cannot be attributed solely to the polarization currents of a charged electrode, for it seems to be essential that a source of e. m. f. be included in the circuit during reproduction. They can scarcely be due to variations in the resistance of the contact surface, for such variations, if caused by hydrogen or oxygen polarizations could hardly be expected to effect in platinum a change of the permanence noted, and, moreover, resistance changes of this character could scarcely occur in the case of silver electrodes and silver cyanide solution noted above, nor can they be due to the variations in frictional resistance due to a polarized electrode, for clear reproductions were obtained when no gas evolution could occur. The authors say: "We believe the following to be the most probable explanation: The fluctuations of the microphone currents cause a superficial disintegration (auflockerung) of the moving electrode, according to the extent of this disintegration, which naturally is connected with an alteration of the polarization capacity, there arise during reproduction fluctuations of the constant current, which actuate the telephone."

On account of the frequently erratic behavior of the device the authors are inclined to disclaim for it any practical utility. It is, of course, obvious that the constructions illustrated are incapable of practical use. A copper disk of 450 mm. diameter, for instance, requires a minimum speed of 60 r. p. m., and at this rate only one or two words can be recorded upon its periphery. Difficulties of this character, however, are readily overcome. The whole device constitutes a most interesting application of electro-chemical principles, and the limits of its possible usefulness can scarcely now be foreseen.

The principle involved in the method is not, broadly considered, novel. United States patent 404,850, granted in 1889 to G. W. Littlehales, presents many points of similarity. This patent covers a method of recording and reproducing articulate speech and other sounds by electro-chemical methods, and like the apparatus of Nernst and V. Lieben. The device consists of two electrodes, one movable and the other stationary, the circuits between them being closed through a thin layer of electrolyte. These electrodes are maintaind in close and invariable relation, and the electrolyte is such that the passage of the current serves, by reason of the liberated products of electrolysis, either to diminish or to increase the resistence of the circuit. The electrolyzing circuit includes a telephonic transmitter, shown as of the variable contact (Blake) type, and the vibrations of the diaphragm cause corresponding fluctuations of the current. Corresponding to these fluctuations, a variable action occurs upon the surface of the moving electrode. For instance, unequal thickness of silver may be deposited thereon, and these irregularities constitute the sound record. For reproduction, acidulated water is substituted for the electrolyte, and a telephone for the transmitter; the revolving electrode now produces fluctuations of the constant current, which the telephone reproduces as sounds. In this apparatus the sound record traces a helix upon the surface of a cylinder as in the ordinary phonograph.

The Value of Telephone Investments.

In a recent study of the subject of investments, Mr. G. M. Walker says that in the interval from September, 1893, to September, 1900, the resources of the national banks of this country increased over 62 per cent, or $1,938,000,000. During this same time the deposits in American savings banks increased over $700,000,000, while those in State banks and trust companies increased some $1,300,000,000 more. The effort to place this enormous amount of new capital aggregating almost $4,000,000,000, has disorganized the entire field of investment. The national banks have completely absorbed the issues of government bonds. There has also been going on a struggle for the great issue of municipal bonds until they command better prices than did government bonds four or five years ago, and mortgage loans, so long regarded as the standard investment for trust funds, are constantly decreasing in volume. He, therefore, thinks the best available investments at present are those of a quasi-public character. He gives the following table showing the charge per capita upon population of quasi-public corporations:

Railroads	$20.00
Street railways	8.50
Gas	3.50
Electric light	2.50
Telephone	1.50

The measure to which these charges can or cannot be reduced in times of business depression in a great degree determines the stability of invstments in quasi-public securities. Mr. Walker considers telephone securities the acme of security and value. Their per capita charge upon the people is the lowest of any quasi-public corporation, because the construction of a telephone plant requires a smaller investment in proportion to the population served than does any other public utility, and the operation and maintenance cost is extremely low when compared with other quasi-public companies. Next to telephone securities he approves of those of gas and electric light companies because they are usually aided by income from municipal sources. The street railways he considers next in the scale as they are largely relieved from the effect of depressing times by the manner in which their receipts are collected.

Automobile Speed.

The State Department has been prevailed upon by those who believe there should be general restriction of the speed of motors in cities, to procure from consuls of the United States reports showing the rules in force in foreign countries that have been constrained to apply rules.

Speed Variations of Engines Direct-Connected to Alternators—II.

(Concluded.)

BY A. H. KRUESI.

IN Fig. 7, *AD* is the line of absolute zero pressure, and *ABCDEFA* represents the pressure at cross-head for one revolution; the point *C*, for example, is found by subtracting the back pressures *NJ* and *NK* from the forward pressure *NI*, resulting in the net pressure *CN*. The net pressure may then be converted into force, and this into turning moment at the crank-pin by resolving into a vertical thrust* and a component along the rod (Fig. 5), when we get:

Moment of crank effort $= \overline{Q-CM} = \overline{P-CN} =$

$$Pr \sin\theta \left(1 + \frac{r\cos\theta}{\sqrt{l^2 - r^2 \sin^2\theta}}\right)$$

In Fig. 8, curves *A* are crank effort diagrams for two strokes, neglecting the inertia of reciprocating parts. The first gives the correct diagram, curve *B*, for one-half revolution, when combined

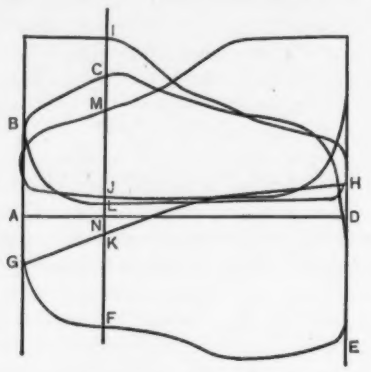


FIG. 7.—INDICATOR DIAGRAMS.

with the inertia curve. It is interesting to note from equation (1) that the inertia increases as the square of the speed of the engine, and from Figs. 7 and 8 that the effect of the inertia of the reciprocating parts is to make the crank effort more uniform.

The area of the diagram enclosed by the base line and the torque curve is the work of a revolution in foot pounds, when the ordinate is moment in pound-feet, and the base the angle in circular measure, or if the ordinate is tangential force in pounds and the base the linear motion of the crank-pin in its circular path. Integrating this area by planimeter we get the mean torque required to do the work of the engine, neglecting internal friction. This can also, of course, be calculated, knowing the output, speed and radius of crank. Any

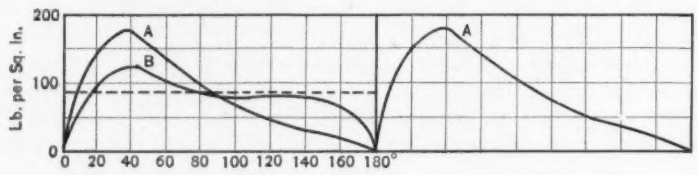


FIG. 8.—CRANK EFFORT DIAGRAMS.

excess or deficiency of torque, with respect to this mean torque, must produce either acceleration or retardation, and from the equation $\Sigma \text{ moments} = \frac{Ia}{g}$ where I = moment of inertia and a = acceleration, we get an acceleration — — θ diagram with the mean torque line as a zero line. From this we can calculate velocity and displacement in terms of θ, but the process* is tedious. We know that the motion is very nearly uniform, and may assume without much error that equal angles are passed through in equal times,* hence our acceleration — — θ diagram at once becomes an acceleration-time diagram, and since $v = at$, the area of this acceleration-time diagram gives velocity and a velocity-time curve. Then since $s = vt$, by integrating this velocity-time curve (that is, taking the double integral of acceleration) we get displacement in degrees and then in phase.

These diagrams may be constructed graphically, but the following tabular method† is easier and more satisfactory. In Fig. 8, curve *B* represents the crank effort diagram, in terms of pounds per square inch of high-pressure piston, for one stroke of a certain cross-compound engine with cranks at 180 degs., intended to drive a three-phase, 48-pole, 400-kw generator at 150 r. p. m., thus giving a frequency of 60 cycles. For simplicity we assume that the diagram for the return stroke is identically the same, and find the mean ordinate to be 86.5 lbs. per square inch. The piston area is 380 square inches, and the crank 10 inches equals .834 ft. long. Hence the mean torque is $86.5 \times 380 \times .834 = 86.5 \times 317 = 27{,}400$ lb.-ft. In the same way we find the torque at equal intervals throughout the stroke, as in column III. of the following table. The flywheel weighs 19,000 lbs., and has a radius of gyration of 4 ft., or a moment of inertia $I = 19{,}000 \times 4^2 = 304{,}000$ in ft.-lbs.-sec. units. Since E, the excess or deficiency between momentary torque and mean torque $= Ia \div g$, we get acceleration in radians per second $= E \times 32.2 \div 304{,}000 = E \times .000106$, from which Column V. is obtained. On the assumption that equal angles are passed through in equal times, we find that 10 degs. represents $\frac{10}{360}$ of .4 second equals .0111 second, since the engine makes 150 r. p. m., or 2.5 revolutions per second, or .4 of a second per revolution. Then, since v, the change in velocity (in radians per second) $= at + c$, we get δv in r. p. m. $= (a \times .0111 \times 60 \div 2\pi) + c = (a \times .106) + c$.

The average acceleration for the first period is:

$$-\left(\frac{2.90 + .774}{2}\right) = -1.837 \text{ and change in } v = \delta v =$$

$(-1.84 \times .106) + c = .195 + c$. r. p. m. for the first period.

In the same way we find that during the next 10 degs. the velocity changes by $-.032 + c$ r. p. m., and so on for the rest of Column VI. But we may save a step in calculation by taking the average E and multiplying by $.000106 \times .106 = .00001124$, thus converting to $\delta v + c$ directly. For example, for the period of 10 degs. — 20 degs.

the average $E = \frac{-7300 + 1600}{2} = -2850$, and

$$-2850 \times .00001124 = -.032 + c \text{ r. p. m.}$$

We must now determine the value of the constant of integration, c. The velocity at any point is the algebraic sum of the change for any period, and the velocity at the beginning of that period, and since we have assumed that both strokes are identical, the velocity curve must repeat itself, that is, must have the same numerical value at the beginning and end of the stroke. This requires that the sum of the positive changes of velocity shall equal the sum of the negative changes or, combined, they must equal zero, whence we get:

$$\Sigma_{180}^{\circ}\, \delta v = -(.8240 + 13c) + (.3786 + 5c) = 0$$

where .8240 is the sum of the numerical parts of all the negative changes and .3786 is similarly obtained. Hence,

$$c = \frac{.4454}{18} = .02475 \text{ r. p. m,}$$

We can now find the value of each δv as in Column VII., and by combining these changes algebraically get the velocity curve as in Column VIII., and Fig. 9. In this figure the velocity is plotted with reference to an arbitrary zero, so that the rise or fall in speed will have for its actual zero line the average speed of the whole stroke or revolution, which is the arithmetical average of all values of the velocity curve. This is indicated by the broken line. From the area of the positive portion of the curve we find a mean rise in speed of .1274 r. p. m. extending from 51 degs. to 171 degs., or through 120 degs. We have already found that 10 degs. represents .0111 second, hence 120 degs. is equivalent to .133 second, or .00222 minute, and angular displacement $= .1274 \times .00222 = .000283$ revolutions. Then phase displacement $= .000283 \times 24 \times 360° = 2.44°$.

But it is obviously incorrect to overlook the velocity change in the other stroke since it will rarely be the same. This should be ascertained in the same way and the mean of the largest gain in speed

* Ewing.
* Perry: Applied Mechanics, p. 270.
* Suppose this involves an error of 1 per cent in t. Then the displacement, or s, which is a function of t, will also be in error by 1 per cent. But the *phase* displacement, which is the result we are seeking, is proportional to (momentary displacement) ÷ (whole displacement or one revolution), hence the error in the result will be a small percentage of 1 per cent, or entirely negligible.

† Perry: The Steam Engine, p. 111. Applied Mechanics, p. 265.

should be numerically added to that of the largest loss, from which the total possible pulsation between two similar engines may be calculated.

The following approximate method, which is shorter but less satisfactory, has been used extensively. It is based on the assumption that the actual curve of acceleration may be replaced by a uniform acceleration having the same mean value, thus giving a straight line for the velocity curve. The mean velocity will then be the average of its maximum and minimum values and the energy stored in the flywheel is $\frac{W}{2g}(v_1^2 - v_2^2)$ where W = weight of wheel in pounds and v_1 and v_2 are maximum and minimum linear velocities of the radius of gyration of the wheel.

To find the energy stored in the flywheel we take the ratio of the unbalanced energy of one impulse to the energy of one revolution and call this K; that is, K is the ratio of the area of that part of B above the mean torque line in Fig. 8 to the area of the whole curve for two strokes, and the unbalanced energy absorbed by the flywheel is the fraction K of the whole energy of a revolution. The energy per revolution in foot-lbs. equals

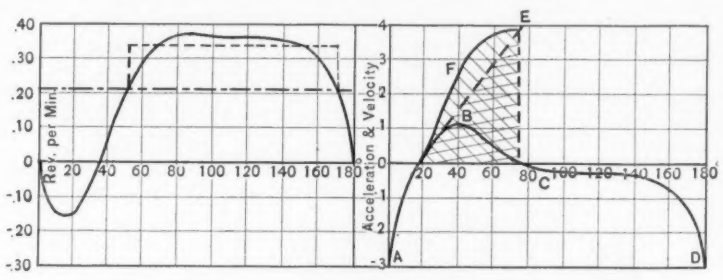
$$P = \frac{KW \times 33000}{.746 \times \text{efficiency} \times \text{r. p. m.}}$$

Then unbalanced energy $= K \times P = P_1 = \frac{W}{2g}(V_1^2 - V_2^2)$

If V_0 = mean speed, we have $\left(\frac{V_1 + V_2}{2}\right) = V_0$, and if we let $\left(\frac{V_1 - V_2}{V_0}\right) = 2s$, we get, by multiplying both sides:

$$\left(\frac{V_1^2 - V_2^2}{V_0^2}\right) = 4s$$

Thus we find $(V_1^2 - V_2^2)$, know V_0^2 and find s, the variation of the maximum or minimum peripheral speeds from the mean, expressed as a fraction of the mean. This variation occurs twice in an impulse, or while $\frac{p \times 360^\circ}{2n}$ electrical degrees are being passed through. The phase-displacement θ is due to the average value of s, or $\frac{s}{2}$, hence $\frac{s}{2}$ is such a fraction of the mean speed as the phase-displacement is of the total angle passed through while s occurs, and we get:



FIGS. 9 AND 10.—VELOCITY AND ACCELERATION CURVES.

$$\frac{s}{2} = \frac{\theta}{\frac{p \times 360}{2n}} \text{ or } s = \frac{\theta \times 4n}{p \times 360} \text{ and } \theta = \frac{s \times p \times 360}{4n}$$

Hence, knowing s, we easily determine the phase displacement. Or, if we wish to know the size of flywheel to limit θ to our 2.5-deg. limit, we find s from the last equation, know P_1, and have $\frac{W}{2g}(V_1^2 - V_2^2) = \frac{W}{2g} V_0^2 \times 4s = P_1$, and taking a suitable diameter for the wheel, find the weight W, or vice versa.

Applying this method to the same engine, in Fig. 8, the area of crank-effort diagram above the mean line is .28 square inch, while the area of the whole diagram for one stroke is 2.7 square inches.

The unbalancing factor is:

$$K = \frac{.28}{2.7 \times 2} = .0518$$

$$P = \frac{400 \times 33000}{.746 \times .93 \times 150} = 127{,}000 \text{ ft.-lb. per revolution.}$$

Unbalanced energy $= 127{,}000 \times .0518 = 6570$ ft.-lb. $= P_1$

$$(V_1^2 - V_2^2) = \frac{64.4}{19000}\ 6570 = 22.3$$

$$V_0 = 4 \times 2 \times \pi \times \frac{150}{60} = 62.8 \text{ ft. per sec. and } V_0^2 = 3950$$

Then: $4s = \frac{22.3}{3950}$ and $s = .00141$

$$\text{Angle} = \theta = \frac{.00141 \times 24 \times 360}{4 \times 2} = 1.52^\circ \text{ displacement.}$$

It is easy to see wherein lies the discrepancy between this result and the one already obtained. In Fig. 10 the acceleration curve $ABCD$ is plotted from the values in the table, and is, of course, similar in form to the resultant torque curve B in Fig. 8. We measure the area of the positive part of this curve and find its mean value, which we take as a uniform acceleration, and construct its velocity curve E (which will, of course, be a straight line) assuming that the velocity is zero at the beginning of the period. This is exactly equivalent to what we do when we take the ratio between the excess area in Fig. 7 to the whole area of crank effort for a revolution, and thus find the mean energy which the flywheel absorbs, thereby changing its speed. But if we construct (graphically in this case) the velocity curve which results from the actual acceleration from instant to instant, we obtain the curve F, which, it will be seen, has a considerably higher mean value, and thus gives a larger displacement than does the straight line velocity curve. Or, in other words, the second method assumes that the velocity changes uniformly between the maximum and minimum values V_1 and V_2, the displacement then being that due to the arithmetical mean of these two values. This would be correct to determine the size of flywheel to keep the velocity variation within given limits disregarding the space passed through while the velocity changes, whereas in the present problem it is the displacement which chiefly concerns us and we cannot properly integrate the velocity curve without first finding its shape, instead of assuming it. It should be understood, however, that great accuracy in determining the phase displacement is useless, since all the conditions are changed for any other load than the one we have been considering and a slight readjustment of the valves may make the engine much worse or much better. What we want to know is the order of magnitude of the phase-displacement only.

I	II	III	IV	V	VI	VII	VIII	IX
Degrees.	Press. sq. in.	Moment.	E excess over average moment.	$a = \text{Accel.} = \frac{Eg}{I}$	Change in velocity $= c = \delta v$	Change in velocity $= \delta v + c$	Velocity.	Average E
..	..	.....	−27,400	−2.90	.....	+.02475	+.025	.....
10	65	20,100	− 7,300	− .774	−.195	−.170	−.145	−17,350
20	94	29,000	+ 1,600	+ .170	−.0320	−.007	−.152	− 2,850
30	117	36,200	+ 8,800	+ .933	+.0584	+.083	−.069	+ 5,200
40	125	38,600	+11,200	−1.186	+.1124	+.137	+.068	+10,000
50	115	35,600	+ 8,200	+ .87	+.109	+.134	+.202	+ 9,700
60	102	31,600	+ 4,200	+ .445	+.0690	+.095	+.297	+ 6,200
70	92	28,400	+ 1,000	+ .106	+.0292	+.054	+.351	− 2,600
80	83	25,600	− 1,800	− .191	−.0045	+.020	+.371	− 4,400
90	80	24,700	− 2,700	− .286	−.253	.000	+.371	− 2,250
100	80	24,700	− 2,700	− .286	−.0304	−.005	+.366	− 2,700
110	81	25,000	− 2,400	− .254	−.0286	−.004	+.362	− 2.550
120	81	25,000	− 2,400	− .254	−.0270	−.002	+.360	− 2,400
130	81	25,000	− 2,400	− .254	−.0270	−.002	+.358	− 2,400
140	79	24,400	− 2,000	− .318	−.0304	−.005	+.353	− 2,700
150	75	23,200	− 4,200	− .445	−.0404	−.015	+.338	− 3,600
160	67.5	20,900	− 6,500	− .690	−.0600	−.035	+.303	− 3.250
170	50	15,500	−11,900	−1.26	−.1034	−.078	+.225	− 9,200
180	..	.....	−27,400	−2.90	−.220	−.195	+.030	−19,650

Colorado River Power.

It is proposed to utilize the power of the Colorado River for electrical purposes. For many months hydraulic engineers have been studying the project and they have just made a report. They declare that in 150 miles of the river's course a dozen times more electrical energy can be secured than is taken from Niagara Falls. If the Government's consent can be secured it is intended to install this summer a plant of sufficient size to furnish electrical power to cities, towns and mining camps within comparatively easy reach of the Colorado, and then to increase the scope of the company until all of Arizona and most of the lower part of California can be supplied from the cañon torrent.

Compounding of Alternators by Compensating Exciter.

BY ERNST J. BERG.

IN an alternating-current generator of r ohms internal resistance per phase, x ohms reactance per phase, e terminal voltage per phase, and a current of $i + ji_1$ amperes, the following relation exists:

$$e_0 = e + (i + ji_1)\ (r - jx)$$

where e_0 is the induced e. m. f.—that is, the no-load e. m. f.—corresponding to the resultant flux due to the combined armature and field excitation.

As this e. m. f. is 90 degs. behind the magnetism, the resultant magnetism can be expressed as follows:

$$M_r = -jke_0 = -jk\,[e_0 + (i + ji_1)\,(r - jx)]$$

The armature m. m. f. is in phase with the resultant current, and can, therefore, be expressed as $n\,(i + ji_1) = M_a$.

Therefore the field excitation, which is the difference between resultant magnetization and armature magnetization, is:

$$M_f = M_r - M_a = -jke_0 - n\,(i + ji_1) =$$
$$i_1\,kr - in - ikx - j\,[ke + ikr + i_1\,kx + i_1\,n]$$

or the absolute value of $M_f =$

$$\sqrt{[i_1\,kr - i\,(n + kx)]^2 + (ke + irk + i_1\,(kx + n))^2}$$
$$= \sqrt{I^2\,[r^2\,k^2 + (n + kx)^2] + k^2\,e^2 + 2\,k\,e\,[irk + i_1\,(n + kx)]}$$

where $I = \sqrt{i^2 + i_1^2}$.

Or, since the voltage across the fields is proportional to the m. m. f., we can express it as follows:

$$e_f = a\sqrt{I^2\,[r^2\,k^2 + (n + kx)^2] + k^2\,e^2 + 2\,ke\,[irk + i_1\,(n + kx)]}$$

The voltage across the alternator fields at no-load is found by substituting $I = O$, thus $e_{f_0} = ake$. Therefore, for a given load I the voltage across the field has to increase from e_{f_0} to e_f, or:

$I = \sqrt{i^2 + i_1^2}$ = resultant current per phase of alternator;
i = energy component of current,
i_1 = wattless component of current,

$\frac{i_1}{i} = tg\ \omega$ $\quad Cos\ \omega =$ power factor.

n equals ratio of the armature reaction expressed in ampere turns to the resultant current.

k equals ratio of resultant m. m. f. of field and armature to the corresponding induced e. m. f.

e equals e. m. f. per phase at terminal of alternator.

r equals resistance per phase of armature winding.

x equals reactance per phase of armature winding.

Perfect control of generator voltage requires, therefore, a device which gives this value of e_x for any current I, and this e. m. f. should be algebraically added to that which the exciter gives at no load on alternator.

A close approximation to this can be obtained by the arrangement invented by Mr. E. W. Rice, Jr., which consists of directly connecting, gearing or otherwise operating an exciter synchronously with the generator, and exciting this exciter by the current of the alternator (with or without the use of current transformers).

It is obvious that an alternating current supplied to such exciter armature will magnetize the machine and cause it to give any desired direct-current voltage, and that the voltage depends not only upon the magnitude of the current, but also upon its phase relation to the field poles.

In practice, one exciter is often used not only to give the required voltage across the alternator fields at no-load, but also to increase the voltage with the load when part of the m. m. f. is obtained by a shunt field, as in a regular direct-current generator, and the increase in voltage with the load by the alternating current entering the armature and magnetizing its field.

The m. m. f. of this alternating current is expressed by

$$M_a = c\ I\ sin\ (\omega + \phi)$$

and the corresponding voltage as $e_a = b\,c\ I\ cos\ (\omega + \phi)$, where c is the numerical ratio between the m. m. f. and the current, b is the ratio between the e. m. f. and corresponding m. m. f., I is the total current of the alternator and ω is the angle corresponding to the power factor of the load, $tg\ \omega = \frac{i_1}{i}$. ϕ is the angle between field poles of alternator and exciter; in other words, the angle which has been chosen in displacing the field of the exciter to give the best results all round.

Were it not that even at full non-inductive load the voltage across the alternator fields has to be higher than at no load, it would be best not to offset the poles of this exciter relative to the poles of the alternator, since then with, say, full inductive load the magnetizing effect of the armature current is a maximum in one direction and with full condenser load a maximum in the other direction, and at non-inductive load no effect takes place, which obviously is just what is wanted. Since, however, considerable compounding is necessary even at non-inductive load, the armature has to be offset from this position and thereby the control made less accurate. All commercial loads are, however, inductive, and therefore it is not of great importance to be able to compound for condenser loads or loads requiring leading current, at least not for such loads of very poor power factors.

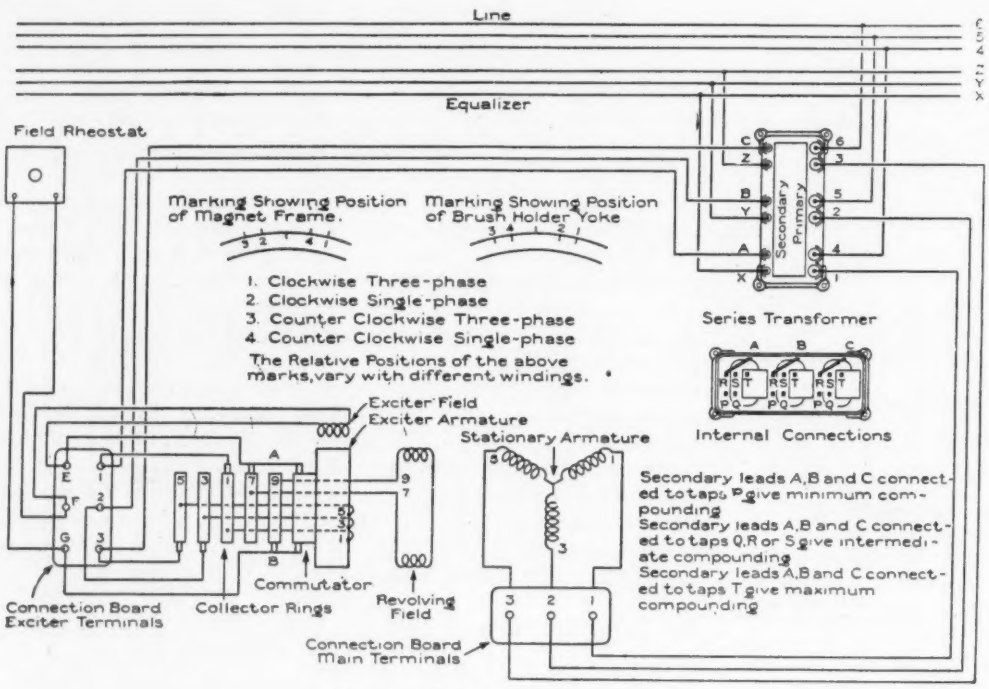

Line
Equalizer
Field Rheostat
Marking Showing Position of Magnet Frame.
Marking Showing Position of Brush Holder Yoke
1. Clockwise Three-phase
2. Clockwise Single-phase
3. Counter Clockwise Three-phase
4. Counter Clockwise Single-phase
The Relative Positions of the above marks, vary with different windings.
Secondary
Primary
Series Transformer
Internal Connections
Exciter Field
Exciter Armature
Stationary Armature
Commutator
Collector Rings
Revolving Field
Connection Board Exciter Terminals
Connection Board Main Terminals
Secondary leads A,B and C connected to taps P give minimum compounding
Secondary leads A,B and C connected to taps Q,R or S give intermediate compounding
Secondary leads A,B and C connected to taps T give maximum compounding

FIG. I.—DIAGRAM OF CONNECTIONS.

$$e_x = a[\sqrt{I^2\,(r^2\,k^2 + (n + kx))]^2 + k^2\,e^2 + 2\,ke\,[irk + i_1(n + kx)]} - ek]$$

and neglecting terms of r^2, since the armature resistance is very small compared with its reactance, we have:

$$e_x = a\,[\sqrt{I^2\,(n + kx)^2 + k^2\,e^2 + 2\,ke\,[irk + i_1\,(n + kx)]} - ek]$$

in which equation ex is the direct current voltage which has to be generated as the load on the alternator changes, and a the ratio of e. m. f. across the fields to the corresponding m. m. f. Also:

the main exciter, and its excitation obtained solely from the alternating current supplied from the main alternator through its armature winding.

The constants of this exciter can be ascertained from the previously given equation by substituting numerical values. For instance, if it is desired that the potential of the alternator shall be exactly the same at no-load, full non-inductive load and a load of 70 per cent power factor, we have:

At full non-inductive load,

$$e_x = e_a$$

$$a\,[\sqrt{I^2\,(n + kx)^2 + k^2\,e^2 + 2\,k^2\,e\,I\,r} - ek] = b\,c\,I\,cos\,(0 + \phi)$$

To take a numerical example:

Let $e = 1$	$I = 1$	$Ir = .0\,I\,e$	$Ix = .25\,e$
$k = 1$	$n = .25$	$a = 1$	$b = 1$

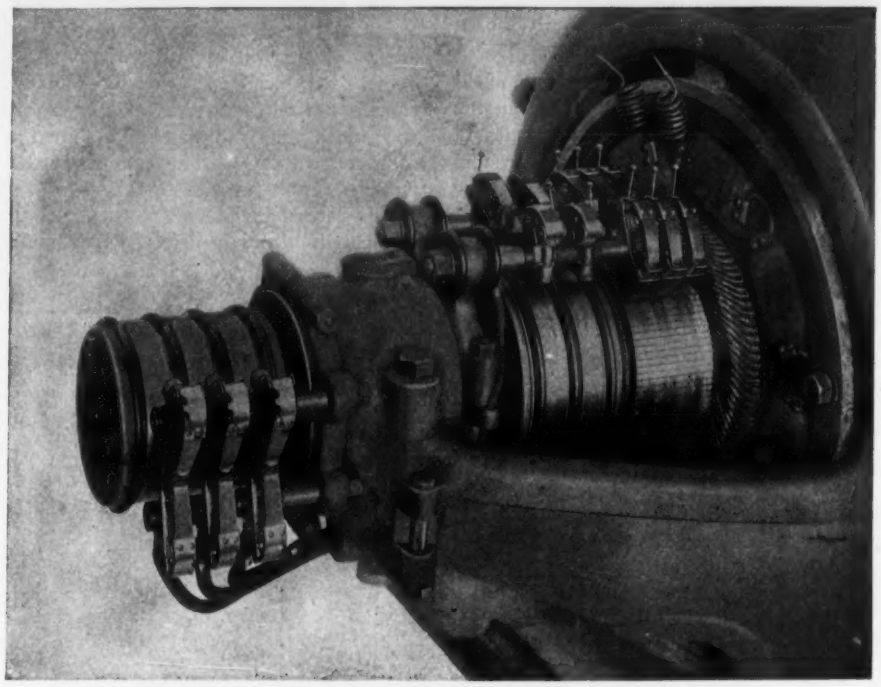


FIG. 2.—COLLECTOR RINGS.

Solving these equations in reference to ϕ and c, we find:

$$\phi = 20° \qquad c = .128$$

By substituting different values of current it will be found that the voltage of the alternator remains practically constant for non-inductive loads and inductive loads of all power factors.

To appreciate what is gained by this control, we find from the expression of ef that disregarding the effect of saturation of alternator fields with the usual separately excited alternator, the voltage would for instance, rise 13 per cent when full non-inductive load was thrown off, would rise 31 per cent if the same kilovolt-amperes at 90 per cent

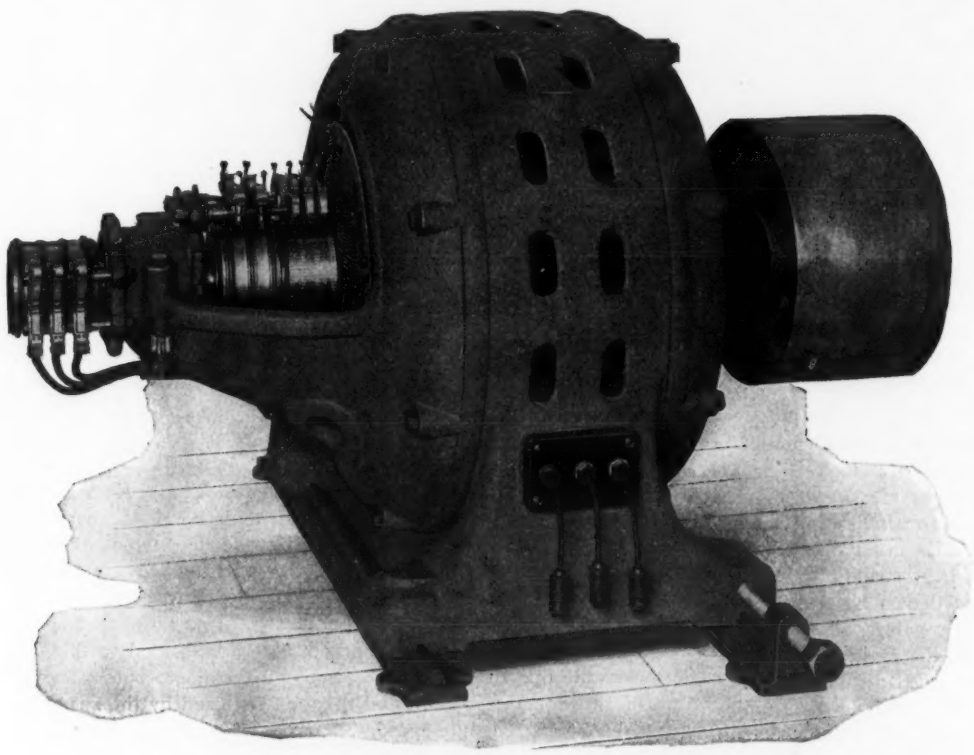


FIG. 3.—ALTERNATOR.

FIG. 4.—ARMATURE.

At 70 per cent power factor, $i_1 = i$, $\omega = 45$,

$$a\,[\sqrt{I^2\,(n + kx)^2 + k^2\,e^2 + 1.42\,ke\,I\,(rk + n + kx)} - ek] = b\,c\,I\,cos\,(45 + \phi)$$

power factor were thrown off, 40 per cent if same kilovolt-amperes at 70 per cent power factor were thrown off, etc.; whereas with the present control, as can be ascertained by inserting proper values, the voltage in these cases is constant within a small fraction of a per cent.

The practical arrangement of this exciter and alternator is illustrated in Figs. 2 to 4, and the connections are diagrammatically shown in Fig. 1.

The alternator itself is a standard machine of revolving field type. The exciter armature with commutator is placed on the same shaft as the fields of the alternator, and this shaft carries in addition two sets of collector rings. Depending upon the system used, one set has three or four rings for a three-phase and two-phase alternator, respectively, which carry the alternating current from the series transformers to the armature winding of the exciter. The second set, which has two rings only, carries the direct current to the alternator field. This exciter is usually wound for 75 volts, which is a convenient voltage, enabling the field spools of the alternators to be made of flat copper ribbons.

The size and character of this exciter is the same as any other directly connected exciter, and with the exception of the collector rings, it is a standard direct-current generator.

Electrical Speed Recording Instrument.

BY FRANK B. RAE.

IN the determination of car operating economy as affecting the selection of the proper size of motors for any specific duty, and also to obtain some knowledge of the efficiency of the man at the controller in relation to the current used in the operation of the car, there seems to be a necessity for a simple and effective speed rgistering device that is capable of drawing an acceleration curve, a continuous speed line and also showing the drift and braking curve of a car as operated by different motormen over a given route. An instrument of this kind, which could be easily applied to any car, would determine many points that are not brought out by the present somewhat elaborate apparatus required in car testing. The methods now used necessitate considerable preparation and several observers, the best results obtained being a specimen run where all conditions are made as nearly perfect as possible. Such a test does not fairly represent the actual everyday work of the car, nor is it a fair basis upon which to calculate the performance of other cars, and none whatever for the personal characteristic of the man at the controller.

The writer has designed an instrument, shown in the accompanying illustration diagrammatically, which it is believed will be of real service to engineers and railway managers in recording the performance of cars on electric, steam or other roads, and which draws a reasonably true acceleration, running, drifting and braking curve. The instrument is also of value in the determination graphically of the speed of revolution of any shaft, and secures an indication of operation not obtainable by the ordinary methods of observation, in that it may be made to record the variations in the speed during one revolution. The several elements of design and construction as combined to produce the desired results are well known, and in their respective uses are entirely reliable.

Referring to the accompanying drawing, there is shown a centrifugal governor of the usual ball type, the speed of which is proportional to the speed of the revolving shaft to be measured. This governor carries an arm for making a record or indicating on a scale, which arm is preferably made to move its indicating or recording point in a straight line by forming it in the shape of a steam engine indicator pencil arm. The governor is driven by a train of gearing from a motor, which may be an electric motor, a weight or spring motor or other suitable means; and in the train of gearing between the motor and governor there is interposed a divided shaft with a friction similar to the friction used in printing telegraph instruments—particularly in the Phelps motor printer. The shaft, intermediate between the driving motor and the governor, has an escapement wheel such as is employed in the stock quotation instrument, and the pallet of this escapement is controlled by a magnet in such manner that the shaft is permitted to revolve only at the speed determined by the oscillations of the escapement pallet. This movement allows the shaft to run one revolution for every eight complete oscillations of the pallet, or to escape one tooth of the escapement wheel for each movement of the pallet.

The magnet releasing the escapement of which the armature forms the pallet, is controlled by a circuit-closing device attached to the revolving shaft or axle, the arrangement being such that a current of one sign is made to energize the magnet during one-half a revolution of the shaft, and a current of the opposite sign operating the magnet during the second half revolution of the shaft; or this effect may be produced each quarter revolution by arranging the circuit closing device to do this. By using an alternating current in this way and a polarized magnet as shown, a uniform and equal strength of movement in both directions of the armature and pallet is obtained.

The record made by the recording hand or pointer is a straight vertical line, and is directly proportional to the speed of the gov-

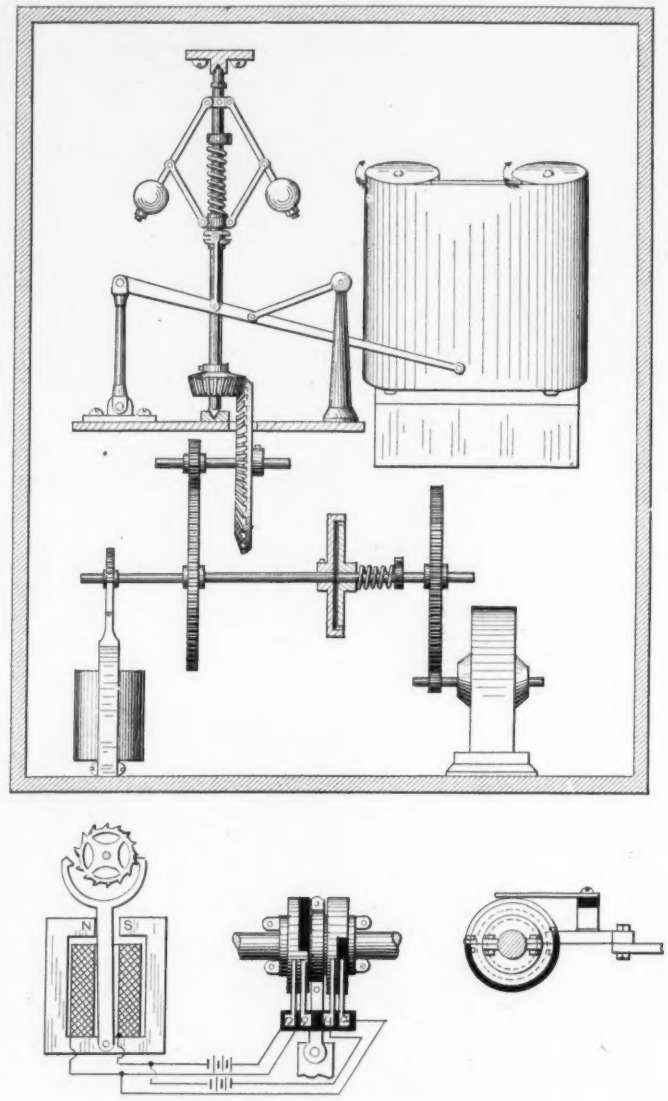


DIAGRAM ELECTRICAL SPEED RECORDER.

ernor as controlled through the escapement. The record is made upon cross section paper, which is drawn underneath the hand by a clockwork chronograph of usual make, by means of which the paper is carried forward at a predetermined rate of speed, say, one inch in 20 seconds. If the vertical section is divided into equal distances representing miles per hour on a scale, say, of 20 miles to the inch, and the movement of the governor pointer is calibrated to this, then the resultant line drawn by the pencil will indicate both the speed and the rate for any instant, and the area enclosed by the speed-time curve shows the schedule speed.

Many further results desirable in the operation of cars will be at once apparent as obtainable with the instrument. Having the curves of the motors, with which the car is equipped, it can be at once ascertained whether the schedule used is within their capacity, or if the cost of maintenance seems excessive it may be shown as due to abuse, which a somewhat slower acceleration would correct, or that

to maintain the schedule demanded with the stops required, larger motors should be substituted.

The instrument is also of value in the inspection of steam roads and could, with advantage, form a part of the equipment of the division superintendent's private car. In this use the performance of the engine and its handling by the engineer is graphically shown, a continuous run producing a continuous record of acceleration, drifting, the use or abuse of air, etc., by plotting a profile of the road on the record made by the instrument a very complete data of train performance would be shown and possibly point out very many economies.

Notes on the Cooper Hewitt Lamp.

BY PETER COOPER HEWITT.

THE purpose of the exhibit which I had the honor to present at Columbia University before the American Institute of Electrical Engineers on April 12, 1901, was:

1. To demonstrate that light can be produced from a gas or vapor in great quantity by means of the electric current, and in the quantity desired.

2. To demonstrate that light can be produced from direct-current low-voltage circuits by means of a gas or vapor.

3. To show that this light is extremely efficient.

4. To illustrate laws of conduction of the electric current by gases or vapors, and to show by experiment the effect of current on a conducting vapor or gas, and the effect of variation in density of the conducting vapor on the current passed.

5. To exhibit the electrical phenomena at the joint of the negative electrode with a gas or vapor.

6. To exhibit practical electric vapor or gas lamps of very high efficiency.

7. To demonstrate that change in the color of the rays of light proceeding from a gas or vapor lamp of this character can be brought about by means of certain materials.

8. To show, by means of curves, that the resistance of a particular vapor in a lamp can be made to vary in a predetermined manner within wide limits by varying the proportion of the vapor subjected to the current and the heat-radiating ability of the lamp.

The demonstrations actually made are illustrated by the accompanying drawings, and the measurements on the drawings were taken by Weston instruments while the lamps were in operation.

Fig. 1 illustrates the relation of the volts to the dimensions of a gas-carrying current. The demonstration consisted in the operation of three lamps illustrating the tendency of the volts to vary directly as the length and inversely as the diameter, as seen by the figures of the drawing. One lamp is 54 inches long and three-quarters of an inch inside diameter, another is half the length and the same diameter, and the third is the same length as the first and twice the diameter. The drop in volts of the second and third is approximately one-half that of the first. The error in the lamp having the greater diameter, which measured 54 volts instead of 45, as should have been the case, was probably due to impurity developing in the vapor and a factor which appears on comparing tubes of widely different diameters.

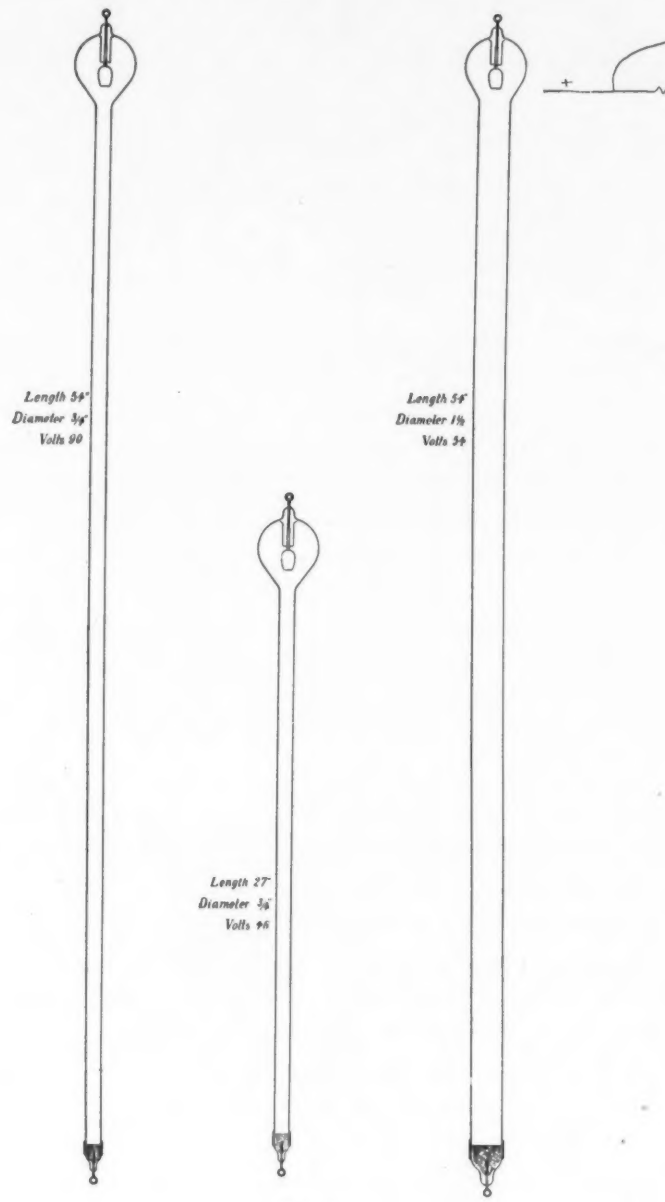


FIG. 1.

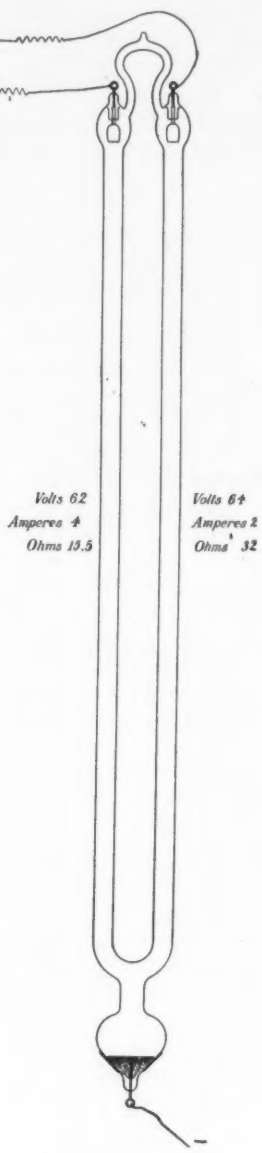


FIG. 2.

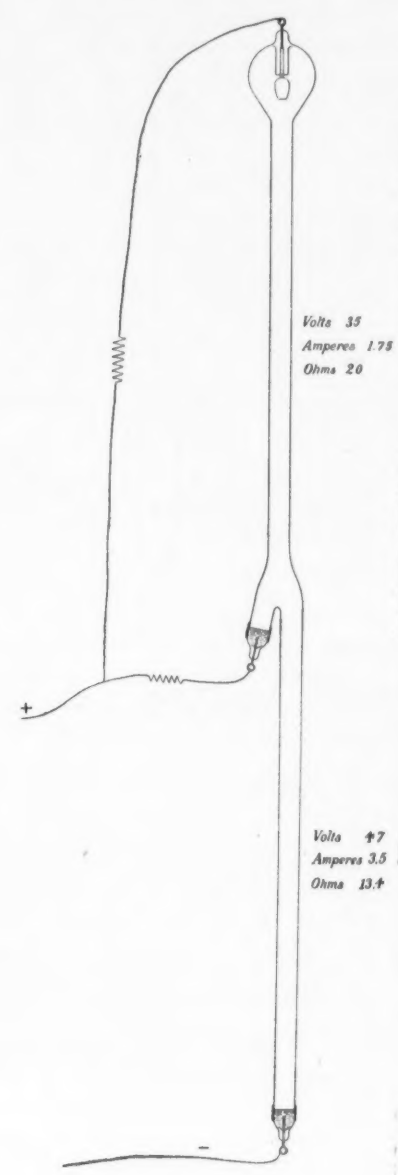


FIG. 3.

Figs. 2 and 3 of the drawings illustrate the relation of current to resistance. The resistance varying inversely with the current, the

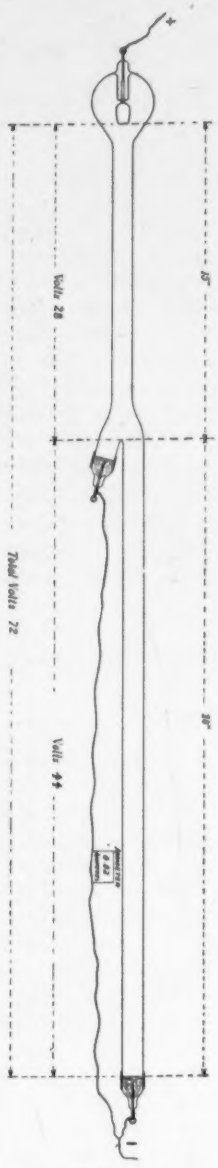


FIG. 4.

Illustrating negative electrode resistance or initial reluctance to allow current to pass. Also illustrating the passage of only a limited amount of current by an electrode prior to having its initial reluctance overcome.

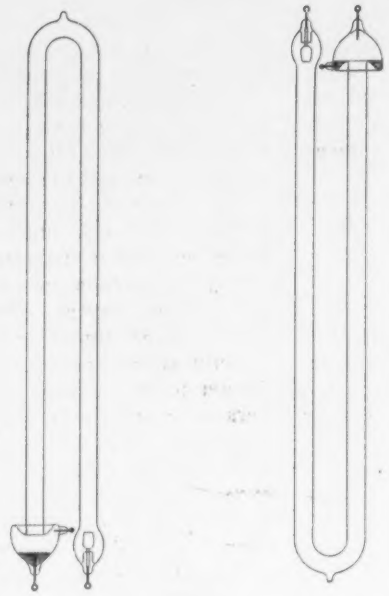


FIG. 5.

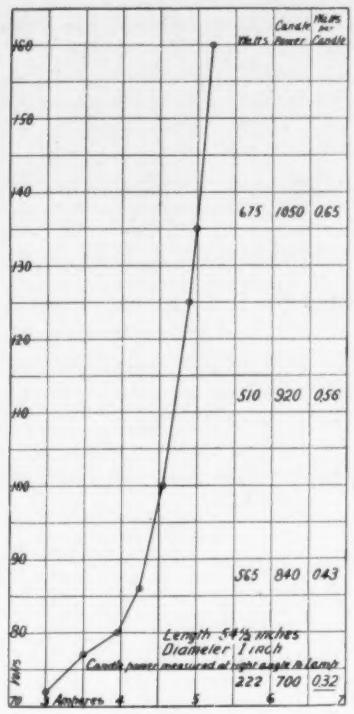


FIG. 7.

FIG. 8.

FIG. 10.

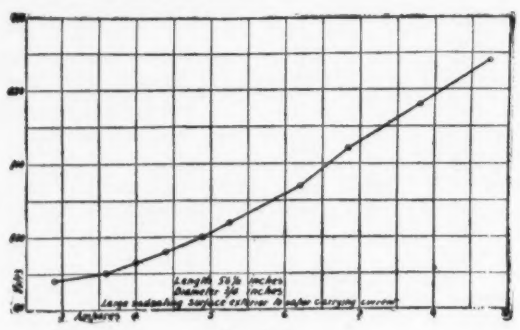


FIG. 9.

FIG. 6.

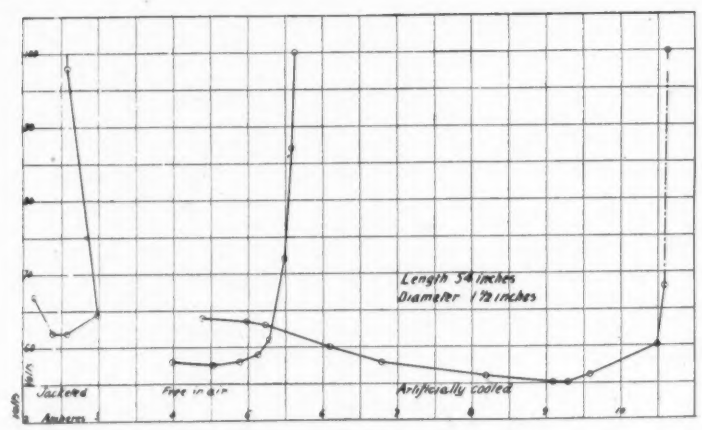


FIG. 11.

FIGS. 4 TO 11.—COOPER HEWITT LAMP.

volts tending to remain constant. Fig. 2 illustrates a divided vapor circuit, one leg carrying four amperes, while the other leg is carrying two amperes, the voltage over each leg being approximately the same.

The second demonstration (Fig. 3) illustrates a divided circuit consisting of a lamp with an additional electrode midway between the other two, whereby the current in the upper portion of the lamp is one-half that in the lower portion. The drop in volts over each of these portions should have been the same and the resistance of one should have been half that of the other, but for the discrepancy which was due to the greater vapor density in the lower portion owing to the presence of the mercury forming the negative electrode.

The next demonstration (Fig. 4) was a lamp having an auxiliary electrode one-third of the distance between the positive and the negative electrode, which on being connected with the negative electrode by a conductor having a negligible resistance, allowed only 0.02 of an ampere to pass through this short circuit, although it was subjected to a measured electrical pressure of 44 volts, while the lamp was passing about three amperes.

These demonstrations practically illustrated results obtained by me from a great number of experiments.

Figs. 5 and 6 illustrate two forms of my lamp adapted to run on a 110-volt circuit with an efficiency of one-half a watt per candle.

Figs. 7, 8 and 10 show actual efficiencies of my lamp at different

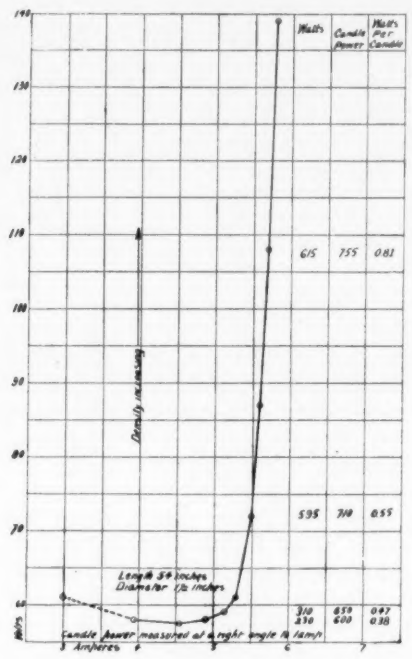


FIG. 12.

electric pressures, while Figs. 7, 8 and 9 illustrate the control of the resistance of the lamp.

Fig. 10 illustrates the electrical variation due to variation in gas density and an immediate effect of variation in current and a result brought about by a variation in gas density.

Fig. 11 illustrates the effect on one of my lamps, of varying its heat-radiating ability.

Fig. 12 is the efficiency curve for the same lamp.

The large lamp exhibited was operated by direct current. The Weston ammeter in circuit with the lamp indicated 7 amperes. The drop in volts across the lamp was 100 volts measured by a Weston voltmeter, and the light given by this lamp was approximately 1500 candles. It was, I believe, the first public exhibition of a high-power vapor lamp, and it was exhibited with standard instruments attached for measuring its current consumption; in fact, all the demonstrations were made with standard instruments attached for general inspection.

CURRENT NEWS AND NOTES.

LIGHTING CANALS.—The Soulanges Canal in Canada is now well lighted by electricity, and the Dominion Minister of Railways and Canals states that the system is now to be extended to other canals there.

PAN-AMERICAN.—Owing to the storm and the heavy snowfall, the Pan-American Exposition will only open in an informal way on May 1, and the regular full-dress exercises will be postponed until May 20.

TELEPHONE CABLE FOR GOVERNOR'S ISLAND.—The Western Union cable boat "Western Union" Thursday afternoon, April 18, laid a four-pair telephone cable from Governor's Island to the Barge Office landing at the Battery. The cable was manufactured by W. R. Brixey, and is owned by the Government. The work was done on the Government's behalf for army purposes.

NEW CONSTRUCTION OF ARMATURES.—A patent issued April 16 to Oskar Lasche, of Berlin, Germany, describes a method of constructing armatures which dispenses with the use of the cast-iron casings and spiders heretofore employed. An iron ring is built of laminæ, which are held together by bolts, and the ring is held together by tension devices consisting of rods set up with turnbuckles.

NAVY YARD DRAFTSMEN.—An examination will be held at the New York Navy Yard on April 30 for eight draftsmen on electrical and other work, at pay ranging from $5.04 to $3.28 per diem. Applications must be filed on or before April 29, with the Commandant there. Details are given in the Navy Yard Order No. 205, issued by Secretary Long. The chief draftsman at the yard is Mr. Edgar H. Berry.

LOCATING METALLIC MINERALS.—A patent issued April 16 to Fred H. Brown describes an electrical method for locating metallic minerals. The method consists briefly in taking electrical measurements over the same length of ground along lines radiating from a central point. Two such central points are chosen so that when the lines representing the radii are plotted the lines intersect. It is stated that the point of intersection of the two lines plotted representing the lowest resistance will be in closest proximity to the body of mineral.

WESTMINSTER ABBEY will fare better and last longer when electric light is installed. A dispatch from London states that a few weeks ago a small marble shaft fell from one of the windows in St. Andrew's Chapel, the iron pin that had sustained it for 600 years having been corroded. Iron pins are doing the same duty in innumerable places throughout the Abbey and further dilapidation is apprehended. To overhaul and renew these pins will be a superhuman labor. Professor Church says that the use of gas as an illuminant in the Abbey, which is a limestone building, sets up a chemical change which is followed by disintegration.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The 153d meeting will be held at 12 West Thirty-first Street on Friday, April 26, 1901, at 8.15 p. m. A paper will be presented by Professor Harris J. Ryan, of Cornell University, Ithaca, N. Y., on "The Transformer for Measuring Large Direct Currents." A paper will also be presented by Professor Frank W. Brady, of the New Mexico College of Agriculture and Mechanic Arts, Mesilla Park, N. M., on "Electricity in Mountain Mines." This paper will be illustrated by lantern slides. The annual meeting of the Institute for the election of officers, presentation of the council and treasurer's report, etc., will be held in New York on Tuesday, May 21, 1901. The list of new candidates for associate membership includes no fewer than 40 names.

SUBMARINE SEARCHLIGHT.—A special telegram from Lakeville, Conn., of April 20, says: The effort to recover the body of Otis Sawyer, of Montclair, N. J., one of the Hotchkiss School students drowned by the upsetting of a canoe, was resumed to-day, when a diver made another descent. As the lake is 70 feet deep at the point where the search is being carried on, the diver has had to work in darkness, with the added disadvantage of being in ooze to his hips. To assist in the search, arrangements were made for the employment to-day of a submarine arc light, the invention of a recent graduate of the Hotchkiss School. Ten thousand feet of insulated wire, brought from New York for the purpose, was connected with a dynamo in the academy grounds to furnish light for the diver's submarine lamp.

ELECTRIC FURNACES.—Among the patents of April 16 are two on electric furnaces, one being issued in the name of the late Lieutenant F. J. Patten, and the other to G. De Chalmot. The Patten furnace is of the open-hearth type, the electric arcs playing downward against an open furnace floor, the process being thus plainly open to view. Each furnace has three working hearths of the form of a sector of a circle, and arranged to revolve in the same horizontal plane about a central supporting post. In revolving, a furnace comes to each of three positions, one for discharging and recharging, a second for preliminary heating and a third for final smelting. The De Chalmot patent refers to the type of electric furnace in which the material is placed in a crucible and subjected to heat generated elctrically and transmitted through the walls of a chamber, in contradistinction to furnaces of the arc type. The crucible is contained within an insulating chamber and rests upon a carbon support which forms one electrode of the circuit. The other electrode is horizontal and in four parts, which bear on the four vertical sides of the crucible.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Direct-Current Generators.—SHORT.—An abstract of a paper read before the Manchester section of the Brit. Inst. Elec. Eng. He remarks that "it is apparent that modern design is tending to a greater number of magnets in the direct-current generator, and it is interesting to see that on the other hand the modern alternating-current machine is being made with fewer and fewer poles." He advocates the standardizing of steam dynamos. He assumes a unit dynamo with one pair of poles, the capacity of which is 137½ kilowatts, and the number of revolutions 800 per minute. He applies the best average working values to this unit dynamo with one pair of poles, and for greater capacities he adds two or more of these units together in the form of multipolar machines, to determine the best relation between speeds and capacities. For instance, without making any changes in the dimensions of the parts or in the electrical and magnetic values, he puts two of these units together in the form of a 4-pole generator. There will now be four poles, but they will have the same section and the same magnet spools. The armature will be doubled in circumference, also the slots and armature coils, commutator bars, brushes, brush-holders and various other parts, all being interchangeable with those of the unit machine. In the same way he constructs an 8, 10, 30-pole dynamo, the results being summed up in a table. This table shows that when certain running values have been established to be used in the construction of multipolar generators, the speed of the machines will depend upon the output. The advantages of such a standard system of design is due to the interchangeability of parts and the certainty of uniformly perfect operation of every machine regardless of capacity. In all sizes of machines the same pole piece would be used. The magnet spools would all be interchangeable. The armature coils would all be alike; the brushes, brush-holders and all the connecting parts would be made after the same patterns. The slots in all the armature laminations would have the same width and depth. "The steam engine stands in the way of accomplishing these results. The speeds and capacities of engines have been established by their makers without reference to the best conditions for the successful operations of the generators they are to drive." He urges builders of engines and direct-current dynamos to co-operate in establishing a standard scale of speeds and capacities for steam dynamos.—Lond. *Elec.*, April 5.

Starting Three-Phase Induction Motors.—An illustrated description of a device of the General Electric Company, of Berlin, by which in starting a three-phase induction motor the armature is automatically short circuited at a certain speed, and this short circuiting is performed for all three phases at the same time and suddenly. This is done by means of a switch mounted on the motor shaft and operated by centrifugal force.—*Elek. Rund.*, March 15.

REFERENCES.

Polyphase Sub-Station Machinery.—EBORALL.—A continuation of his illustrated Brit. Inst. Elec. Eng. paper. He deals at some length with the regulation of the power factor. He discusses the no-load "V" curve of a synchronous machine. He speaks briefly on the overload capacity of polyphase sub-station machinery and begins to discuss parallel running.—Lond. *Elec.*, April 5.

Starting Three-Phase Motors.—BERGMANN.—An illustrated description of a method of calculating the starting resistance and its single steps, for three-phase motors.—*Zeit. fuer Elek.*, March 24.

POWER.

Printing Establishment.—GRIGGS.—An illustrated description of the electric plant of the Curtis Publishing Company, of Philadelphia. It furnishes light, heat and power; 220 volts direct current is used throughout for light and power. Underneath the presses, on the floor, there are nearly 100 motors. Each press motor is provided with two controllers. One is a series controller, or starting box, used when "making up" or starting slowly, and is never in use for more than a few seconds at time. It brings the motor up to about half speed. For the regular operation of the press, the particular speed required under the varying conditions, is obtained from the second controller, which is a special rheostat in the shunt field; by increasing or decreasing the amount of saturation of the field, the speed is varied. The motors are located underneath the apparatus, driven in such a position that they take up no floor space. He calculates that he erection of an isolated plant has resulted in a very considerable saving.—*Elec. Rev.*, April 6.

TRACTION.

Liverpool.—This city is now completely equipped with electric railways, the work having been completed during the present year. In 1897 a special committee decided that the city should own the tramways, and that electric traction should be installed. There are two main stations, which are similar to each other. The Pumpfield station is situated on a canal, and receives its fuel by water. The Lister Drive station is situated on the railway track, and receives coal in cars. The former plant obtains condensing water from the canal, the water for the condenser in the Lister Drive station being cooled by cooling towers. The equipment of the stations consists of six sets of Willans condensing engines direct connected to Siemens Brothers' generators. Four of the engines at one station are compound, and the remainder in both stations are triple expansion. The capacity of the engines is 1200 horse-power. On the wall near the engines are steam gauges and voltmeters. The stations supply both light and power to the city, and there are two switchboards in each station, one each for the different services. These are so arranged that by transposing connections to the switchboard, and engine and dynamo may be used either for lighting or transmission service. A battery of storage cells is connected to each station, which has a capacity of 200 ampere-hours, and is used to assist in balancing the load to the two sides of the three-wire supply for the lighting service. The boiler houses are situated on either side of the engine room. It is thus divided into two distinct parts, each half supplying the engines on that side of the building. The boilers are of the Lancashire type, and there are 14 on each side. Mechanical stokers are used. Besides these two main stations, there are several smaller stations distributed throughout the city. In one of these refuse destructors are used. The rails are laid on a bed of concrete. All the curves are fitted with renewable hard steel strips and bolted to the rails. Several types of cars are used on the road, but the standard car is double deck, with three large windows on the side. It has a reversed staircase, which has given great satisfaction, and is claimed to prevent accidents and allow a greater facility in ascending the stairs. There are large repair shops situated on Lambeth Road, capable of holding 60 cars. All the repairs are done at the main shops, only the lightest kind being undertaken at the car sheds. The overhead construction consists in a large part of the center pole type. These poles are used to support both incandescent and arc lamps, and add materially to the appearance of the

streets. On narrow streets side pole construction prevails as well as rosettes. The growth of this company in the last few years has been very great, the total number of passengers for 1897 being about 38,000,000, and for 1900 about 82,000,000.—*St. R'y Jour.*, April 6, and Int. Ed., April.

Notes on Seattle Street Railway Practice.—This company has employed soldered rail bonds for three years with good satisfaction. The bond is illustrated and consists of seven layers of sheet copper, each about 1 inch wide and .025 inch thick. The bonds are about 8 inches long, and about ½ inch at each end is tinned when the bond is made, and that much is soldered to the rail. The remainder of the bond is bent into a U-shape. These bonds are fastened underneath the base of the rail. The method of soldering is described in detail, and consists briefly of heating the rail with a powerful gasolene brazing torch, and then soldering in the usual way, using plenty of solder and heat, and protecting the end which is soldered from the heat which is used to solder the other end of the bond. The block signal system of the company which operates a good deal of single track road is then shown diagrammatically. It differs from other block signal systems principally in the use of a lamp in the middle of the block to indicate that the system is in working condition, and also from the fact that the block can be set by the motorman without leaving his car. This is done by the use of a small switchbox, suspended from one of the span wires and provided with two cords, one of which is pulled by the motorman. The form of snowplow used by the company is shown. It is connected between two cars. Some particulars are then given of the freight business done by the company and its method of settling accident claims. A novel flexible bracket employed on the overhead line is shown. The arm is hinged near the pole and is suspended by a wire from the pole to the end of the bracket or arm. An extended description is then given of the operation up steep grades by means of counterweights. This method has been described briefly before, but is shown in detail.—*St. R'y Jour.*, April 6, and Int. Ed., April.

REFERENCES.

Chicago.—An illustrated description of the power plant of the Northwestern Elevated Railroad which is the latest of the Chicago elevated roads to be completed. There are four generating units of together 5250 kilowats.—*West. Elec.*, April 13.

New Zealand's First Electric Railway.—This is a line 1½ miles in length, near Dunedin. The cars are short and equipped with two 25-hp motors, on account of the grades of 8½ per cent. The line was opened Dec. 4. The principal railway in Dunedin will also be acquired by the municipality and equipped with electric power.—*St. R'y Jour.*, April 6, and Int. Ed., April.

Tramway Brake.—An illustrated description, taken from a patent specification of a brake invented by Planta. By an electromagnetic device brake shoes are released which fit the rails and against which the wheels are running and thus are braked.—*Schweiz. Blaett. fuer Elek.*, March 22.

Tramway Motor.—Short.—An illustrated description of "The construction of an electric tramway motor." A full description is given of the various stages of manufacture of a standard type made by the English Elec. Mfg. Co.—Lond. *Elec. Rev.*, March 29, April 5.

Monorail Electric Traction.—Behr.—A rather long abstract of his recent lecture on the proposed high-speed electric monorail line between Liverpool and Manchester, a briefer abstract of which was noticed in the Digest, April 6.—Lond. *Elec. Rev.*, March 29.

Automobiles.—A series of articles on "The automobile industry in the United States," comprising a brief article by Maxwell on "The industry in brief." An illustrated description of the wiring connections of an electric automobile. Brief and partly illustrated descriptions of electric automobiles of different American companies, etc.—*Elec. Rev.*, April 13.

Installations, Systems and Appliances.

Three-Phase Extensions in Manchester.—An illustrated article on the scheme of electricity supply over 45 square miles, for lighting and traction purposes. Direct current will in all cases be delivered at the consumers' terminals and to the tramways. The distribution will be by a five-wire network in the central part of the city, and from a three-wire network in the remainder of the area, with a pressure of 400 volts across the outers in each case. The tramway network will be supplied at a pressure of 500 volts. Both networks are to be fed partly by current generated at low pressure and partly by high-tension current. The present station, in which current is generated at 440 volts, is to be retained and to be supplemented by an additional generating station, now in course of erection. The capacity of these two stations will be 26,000 horse-power together. These two stations will eventually supply all the demand within a half-mile radius from them. The remainder of the network will be supplied from a single generating station on the eastern border of the city. Here three-phase current will be generated at a pressure of 6500 volts, and be transmitted to sub-stations, placed about a mile apart and containing transformers and synchronous converters, the arrangement being made that two distinct pressures are obtained, 420 volts for lighting and 500 volts for traction. Each sub-station is designed to supply a radius of about half a mile. The three-phase generating station would eventually have a capacity of 50,000 horse-power.—Lond. *Elec. Eng.*, April 5.

Insulation on Cables.—O'Gorman.—The conclusion of his long Brit. Inst. Elec. paper (Digest, April 6, 13), together with the discussion that followed. Swinburne said this was the first scientific paper written on the subject, but he thought that O'Gorman's calculations on "grading," when reduced to practice, would be found to be misleading. The really best cable would be a matter of compromise and experiment between layer and layer, and was not a thing which could be calculated out carefully.—Lond. *Elec.*, March 29, April 5.

REFERENCE.

Switzerland.—A reprint of the Swiss law of 1900 concerning electric installations.—*Rev. de l'Elec.*, May 31.

Electro-Physics and Magnetism.

Dielectric Losses.—Drysdale.—An illustrated article on "Dielectric losses in condensers and cables, and their bearing on electrical supply." He first calls attention to the importance of this question in alternating-current practice. He has made some laboratory tests on both cables and condensers. In a table he gives the results of his measurements of the losses in dielectrics. A number of measurements of the capacity of the cables and condensers were also made at different potentials during the tests, by observing the current and p. d., the wave form being approximately sinusoidal. While Mordey had recently found the capacity to be constant in this case, the present author found the capacity in most cases increasing at high pressures. In a table he gives a summary of the measurements made by Ayrton, Mather, Hoor, Addenbrooke and himself, of the power factor in different condensers and cables. It appears that the power factor for most dielectrics when new lies between 0.02 and 0.03; but it seems that this may be largely increased with age or treatment. In view of the important part which cables and condensers play in alternate-current working, this matter seems worthy of especial investigation.—Lond. *Elec.*, April 5.

Electric Arc.—Child.—An article on the velocity of ions drawn from the electric arc. A study of the rate of discharge from an arc to a neighboring body, shows that under varying conditions of difference of potential, distance and current, in the arc itself, the positive ions drawn out from the arc move more rapidly than the negative ones. This is not to be explained as an effect due to ultra-violet light. The positive ions from a carbon placed in an oxy-hydrogen flame, also move the more rapidly than the negative. In cases of an arc between metals the negative ions move the more rapidly. While his work does not prove that the positive ions in the arc itself move more rapidly than the negative ones there, it is in every respect consistent with such a hypothesis, and it shows that it is possible for the positive ions to do so.—*Phys. Rev.*, March.

Coherers.—Kinsley.—An article on coherers suitable for wireless telegraphy. For this purpose the most sensitive coherer is the one which, with unchanged conditions at the transmitting station, will receive the signals when its own aerial wire is the shortest. He recommends the following method of testing, which he calls the direct potential difference method. If a coherer has a p. d. between its terminals when its resistance is high—practically infinite—its resistance will be unchanged as the potential is raised until a certain value is reached when the resistance will suddenly fall. The more sensitive the coherer, the smaller is the p. d. necessary to produce this sudden change in its resistance. He gives in tables the results of various tests of coherers. He emphasizes the fact that the sensitiveness does not depend on the metal or metals used. Coherers of any degree of sensitiveness desired may be made of any metal. It is only necessary to treat each metal in accordance with its peculiar

nature. In general, the more readily the metal oxidizes, the more carefully must it be manipulated. Nickel is a very satisfactory metal to use, as it can be handled in the open air and can easily be made to give any sensitiveness and ultimate resistance desired for wireless telegraph work. The local p. d. he has found best to use is 0.4 volts. As the current must also be kept small, say, less than 0.002 ampere, it is obvious that a very sensitive relay must be used. He has found that a relay which is operated by a current of 0.001 ampere is the most satisfactory.—*Phys. Rev.*, March.

Metallic Reflection of Electric Waves.—Lindmann.—In his experiments on the reflection of electric waves by metallic surfaces, Righi had claimed to have discovered an elliptic polarization of the waves by reflection; but this elliptic polarization is very improbable for theoretical reasons. The present author has repeated Righi's experiments with improved apparatus and did not detect any ellipticity. As regards positive results, he is inclined to attribute them to disturbing reflections.—*Ann. der Physik.*, No. 3; abstracted in Lond. *Elec.*, March 29.

Solar Corona.—Bigelow.—An article on "The magnetic theory of the solar corona." The coronal effects at the sun are explained by a magnetic field in conjunction with an electric discharge radiation acting upon ionized products. The earth is immersed in a true external magnetic field, and the variations on the normal type are explained by the action of the ionization in the atmosphere, the ions being generated by the electromagnetic radiation. The base of the magnetic field in which the earth is immersed is in the sun. The earth rotates with the field in space. Consequently, the 11-year period of the earth's magnetic and meteorological elements is caused by efficient internal solar process. The 26.68-day period, by the sun's axial rotation; the semi-annual "inversion of the type curve," by exposures to the solar lines at the earth in different aspects, such that oppositely directed couples are produced twice annually.—*Am. Jour. of Sc.*, April.

Phosphorescent Glow in Gases.—Burke.—The conclusion of his long investigation of the phosphorescent glow in gases. His results are summed up as follows: The glow is a volume effect. It consists of unelectrified particles. It is not the result of the recombination of ions liberated by the spark, as these ions travel down the long tubes away from the spark, but is the result of the production of molecules in the bulb by the spark directly. An e. m. f. has no effect upon the glow. The glow conducts as it passes through the gas. The destructive effect of sparks on the glow is due to cathode rays or fast-moving negative ions. The glow is due to impurities, but oxygen is a necessary element, and most probably ozone, but they are not sufficient by themselves. There is an analogy between the glow and thermoluminescence which is of importance. There is a certain amount of energy stored up in the gas by the passage of the spark. The glowing particles resemble in some of their properties the emanation from thorium. The phosphorescent particles appear to be one kind of particles emanating from the sparks quite distinct from those molecules to which the explosive pressure is due. The conductivity appears to be electrolytic, depending upon the presence of impurities. The phosphorescent particles appear to be large molecular groups formed by the spark whose existence may be maintained for some time, notwithstanding the bombardment from the molecules of the gas, in consequence of repulsion which they must exert on molecules that approach them.—*Phil. Mag.*, April.

Crookes Tube.—Willows.—An account of an experimental investigation of the absorption of gas in a Crookes tube. It appears that most, if not all, of the gas absorbed is to be accounted for by a chemical combination with the glass. That if tubes are desired in which the pressure remains constant they should be made of Jena glass in preference to lead glass, and of lead glass rather than of soda glass, and finally that in the first two cases hydrogen is absorbed to a far less extent than air or nitrogen, the last two gases showing little difference.—*Phil. Mag.*, April.

REFERENCES.

Analyzing Distorted Waves.—Langsdorf.—A description of "A graphical method for analyzing distorted alternating-current waves." The method merely requires the use of circles and straight lines.—*Phys. Rev.*, March.

Cathode Rays.—J. J. Thomson.—A paper in which he first gives an account of an experimental investigation of a kind of easily absorbed radiation produced by the impact of slowly moving cathode rays. He also gives a mathematical theory of the negative glow, the dark space, and the positive column, based upon the hypothesis of corpuscles.—*Phil. Mag.*, April.

Coherer.—Schlabach.—A summary of our present knowledge on coherers, with a very long list of articles and papers on this subject.—*Phys. Zeit.*, March 30.

Electro-Chemistry and Batteries.

Storage Battery.—An illustrated article on the Rosenthal storage battery. It is claimed that it will stand heavy over-discharge, and that although the plates are of the pasted type, they can be charged in a very short time, with a charging current of four or five times the usual rate, without sustaining any permanent injury. The plates have central supporting grids of lead designed to allow free expansion of the paste in every direction during the process of forming and when in use. The grids consist of vertical rods having a diamond section, and of interconnecting horizontal bars having a circular section, the positives and negatives being similar except in thickness. The paste is a mixture of finely powdered lead oxide, and a preparation of an inert material, with a solution of specially treated sulphate salts, the object being to make a very coherent and yet extremely porous material. Some results of tests are given. One is as follows: A battery of 140 ampere-hours nominal capacity, at 20-ampere charge and discharge; charge at 20 amperes for 9 hours, 180 ampere-hours; acid solution, 1.170 to 1.300; discharge at 20 amperes for 8 hours, 160 ampere-hours, at 2.01 to 1.8 volts; ampere-hour efficiency, 88.9 per cent; weight of plates with terminals and separators net, 19 lbs.; weight of complete cell, 23.75 lbs.; watt-hours per pound of plate (average 1.95 volts), 16.38; watt-hours per pound of complete cell, 13.1. "This cell was taken from a battery of 36 cells, which had been in use for 9 months in a motor car, running over 500 miles on ordinary roads, many times discharged at 60-ampere rate, and at an average discharge taken as 25 amperes."—Lond. *Elec. Rev.*, April 5.

Primary Batteries.—Reynier.—A description of two new batteries by Fontaine-Atgier, which were shown at the late Paris Exposition and seem to be intended chiefly for medical apparatus. In the first the depolarizing action is due to an iron wire gauze which offers a very large surface for the hydrogen to escape. It is a zinc-iron couple, the solution being caustic soda. The e. m. f. is 0.45 volt, and the internal resistance is very low. It is claimed to be quite as constant as one in which there is a perfect chemical depolarization. With a gauze of copper or brass the e. m. f. becomes 0.95 volt, but the depolarizing action is far less energetic. With silver, the e. m. f. is 1.25, but the depolarizing action is very poor, from which it is claimed that the iron has an action peculiar to itself. Some data are given, among which the difference of potential after the initial drop is given as 0.22. The second cell described has two liquids like the Bunsen, but instead of the sulphuric acid, he uses a strong solution of caustic soda and in place of the nitric acid, he uses a secret nitrogenous mixture which avoids the production of bad odors, as the vapors are transformed almost entirely into ammonia. The e. m. f. is 3.20 to 3.5 volts. The difficulty lies in the porous cup. These are described and he has found one which will stand the action. The retaining vessels are made of sheet iron, and the batteries have a small weight. The cost of the energy with these is said to be about 80 cents per horse-power hour.—*L'Elec.*, Feb. 9.

Electromotive Force and Osmotic Pressure.—Lehfeldt.—A long paper, in which he develops an expression for the e. m. f. of a concentration cell, with or without migration, by means of a thermodynamic cycle. The expression, which is applicable to strong as well as weak solutions, is given first, on the assumption of Boyle's law, in terms of the degree of dissociation of the salt as found from the electrical conductivity; afterwards, without that assumption in more general terms. According to this expression the e. m. f. of a cell depends on the total osmotic pressure of the salt, not on that of the metallic ion only. Experiments are then described, both old ones recalculated and new ones made for the occasion, in which the e. m. f. of concentration cells of chloride of zinc and sulphate of zinc are measured, the results being expressed by curves and tables. From the data thus provided the osmotic pressures of those salts in solutions nearly up to the points of saturation, are calculated, and the analogy between those pressures and the pressures of highly compressed gases pointed out.—*Phil. Mag.*, April.

Electrolytic Oxygen and Hydrogen.—Buffa.—A long article in which he discusses the industrial electrolysis of water under five sections—electrolytic cells, chemical changes, industrial installations, industrial yields and applications. He describes the cells of Renard,

Garuti and Del Proposto. The first uses diaphragms of asbestos, the others metallic diaphragms which have proved more satisfactory. "These are of thin sheet steel, it having been found that below pressure of 3 volts these sheets act as diaphragms and not as secondary electrodes, as one would have expected." He describes the electrolytic plant at Rome, designed by Bossi and Bassani, for the production of hydrogen for inflating military balloons. High-tension alternating current is furnished by a supply station, and is transformed into direct current at 50 volts. A 14 per cent sodium hydrate solution is used with iron electrodes, a film of oil covering the surface of the electrolyte. At Rome, 1 horse-power-hour, measured at the terminals of the primary circuit of the transformers, yields 0.086 cubic meter hydrogen gas. At Brussels 1 horse-power-hour, measured at the terminals of the decomposing cell, yields 0.12 cubic meter of hydrogen. At Rome the kilowatt-year costs 96.6 francs, and the cost of 1 cubic meter of hydrogen and ½ cubic meter of oxygen is 20 centimes, interest and depreciation charges excluded. The cost of a 100-hp installation, with the necessary pumps for compressing the gases produced, is estimated at 110,000 francs.—*Ass. Ing. El. Liege, Bull.*, Sept. 30, 1900; abstracted in *Science Abstracts*, March.

REFERENCE.

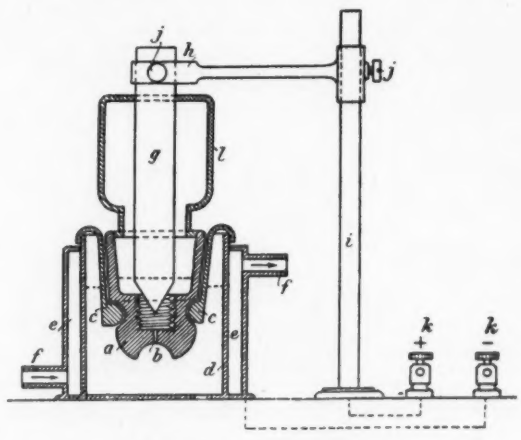
Frasch Process.—An illustrated article on the Frasch electrolytic process for refining nickel, which was noticed in the Digest, Sept. 22. This description is a summary of five recently issued United States patents.—*Eng. and Min. Jour.*, April 6.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Static Voltmeter for High Tensions.—BENISCHKE.—A brief illustrated paper read before the Electrotechnical Society, of Berlin. He showed a high-tension voltmeter of the Gen. Elec. Co., of Berlin, with two scales, one up to 7500 volts, the others up to 25,000 volts. As far as the 7500-volt scale is concerned, it is an ordinary static voltmeter. The second scale to 25,000 volts is obtained by means of condensers. The arrangement is based upon an older suggestion of Peukert, who had recommended reducing high-tension measurements to low-tension measurements by connecting several condensers in series and shunting one of them by a static low-tension voltmeter. As seen in the adjoining diagram, the present author uses the same idea to get a second scale reading up to 25,000 volts, besides the original scale, reading up to 7500 volts. The dielectrics of the condensers consist of micanite, placed below the bottom of the instrument. Both scales are obtained by calibration.—*Elek. Zeit.*, March 21.

STATIC VOLTMETER.

Electrolytic Interrupter.—HAERDEN.—An illustrated description of an electrolytic interrupter, which has been in use continually for several weeks proved successful. It is a modification of the Caldwell interrupter. In the bottom of a china insulator *a* a hole *b* of about 1.5 mm. diameter is drilled. The insulator is suspended in a lead cylinder *d* by means of a lead ring *cc*. The cylinder *d* is surrounded by the cylinder *ee* for water cooling. The lead cylinder *d*



ELECTROLYTIC INTERRUPTER.

is the cathode, while a lead strip *g* is the anode, which can be raised or lowered at will; *k k* are the terminals for the electric circuit. Dilute sulphuric acid of 23 degs. B. is used as electrolyte. To prevent spilling of the sulphuric acid, a bottle *l* with a hole in the bottom is placed above the insulator. He found that lead was the best metal to use. It will be seen that the interruptions occur at the hole *b* which connects the two portions of the electrolyte in the cylinder *d* and in the insulator *a*. During the operation he observed a peculiar periodical change of the level of the electrolyte in the insulator, which, however, has an influence upon the successful operation of the interrupter.—*Elek. Zeit.*, March 21.

Clark Cell.—CARHART.—A summary of the various determinations which have been made of the e. m. f. of the Clark cell. If Clark's own determination is omitted, because his cells, when set up with boiled zinc and mercurous sulphates, are not comparable with the others, then there remain only three absolute determinations by others. The mean of these is 1.4333 volts at 15 degs. He is convinced that the e. m. f. of the Clark cell at 15 degs. C. is nearer 1.433 than 1.434 volts.—*Phys. Rev.*, March.

REFERENCES.

Ballistic Galvanometer.—ROBERTSON.—The first part of a mathematical article, illustrated by diagrams, on "The apparent resistance of a ballistic galvanometer of the moving coil type, and a method of allowing for the damping current."—Lond. *Elec.*, April 5.

Rheostats and Bridges.—EDELMANN.—A brief illustrated article on sliding rheostats and bridges, of precision.—*Elek. Zeit.*, March 21.

Effect of Tramways on Magnetic Observatories.—A reprint in full of the paper by Ruecker "On the magnetic field produced by electric tramways." Also of the paper by Glazebrook, giving "Notes on the practical application of the theory of magnetic disturbance by earth-currents," which were noticed in the Digest, Jan. 12.—*Phil. Mag.*, April.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wireless Telegraphy.—GUARINI and PONCELET.—An article on the part played by the antennæ in wireless telegraphy. They arrive at the following conclusions. "Instead of the long, vertical antennæ employed up to the present, it is only necessary to arrange small antennæ (about 1 meter in length), provided or not with Hertzian reflectors, arranged parallel in the two corresponding stations, and in such a position as to be comprised within the normal planes passing through their extremities. It does not matter whether they are horizontal, vertical or oblique, so long as the above-mentioned conditions are fulfilled. If between the two stations there are any obstacles such as the curvature of the earth, metallic objects, houses, trees, etc., which absorb the radiations, the distance of transmission will be diminished, and communication may even be stopped. In this case the two antennæ must be raised so as to be above any obstacles. At sea the curvature of the earth has less influence, as the electric waves pass through the water, and in this case the absorption depends on the quantity of salt in the water. The curvature of the earth only intercepts wireless telegraphy waves at sea at long distances, when the electric waves come in contact with the bottom of the sea."—Lond. *Elec. Rev.*, April 5.

REFERENCES.

Statistical.—Statistical articles on telegraphy and telephony in Hungary in 1898 and 1899, in Austria in 1899, in Sweden in 1897 and 1898.—*Jour. Teleg.*, March 25.

Congo.—An article on the construction of the telegraph line from Loango to Brazzaville.—*Jour. Teleg.*, March 25.

Coherers for Wireless Telegraphy.—See the abstract of Kingsley's article under Electro-Physics.

MISCELLANEOUS.

Electrical Heating of Metals.—DE TUNZELMANN.—A very long article. He discusses the method of applying electro-fusion to casting. He says that the premature cooling of the upper surface of a steel casting is the cause of faulty castings. The supper surface of the casting should, therefore, be kept in a fluid state while the lower portion is solidifying. For this purpose the liquid metal surface is made to form the positive pole of an electric arc, while a steel or carbon rod forms the negative pole. The latter can be raised and lowered by a special mechanism. The thick iron walls of the mold have a thin metal prolongation lined with firebrick, or similar resisting material. The fused metal does not stick to this, and since the

firebrick is an insulating material, no arc will be formed between the rod and the sides, and hence the latter will not be destroyed as might happen if no firebrick were interposed. Experiments have shown that for the treatment of three blocks of crucible steel, each weighing about 6 tons, and one block of Martin steel of about 14 tons, a direct current of 800 amperes at 60 to 70 volts is necessary. Calculations as to the cost of production of steel by the above method show that Martin steel costs about 10 per cent less and crucible steel 22 per cent less than when made in the ordinary way. Three processes in commercial use are described in detail, namely, the Bernados process of electrofusion, the Voltex process of electrofusion, welding, brazing, etc., and the Thomson process of electric welding. Data are given as to the amount of current used in these processes. He claims that the Voltex process of electric heating is far cheaper and more economical in many phases of manufacture and repairing than methods now in use. In the brazing and filing of a cycle frame the cost of the old method by gas and coke is $1.43 against 46 cents by the new one.—*Feilden*, Oct., Dec.; abstracted in *Science Abstracts*, March.

New Books.

THE THEORY OF COMMUTATION. By C. C. Hawkins. London: Geo. Tucker. 81 pages, 24 illustrations. Price, 2 shillings, sixpence.

This pamphlet is a reprint of a series of articles which appeared in the London *Electrician* about the end of last year. It is intended for those who are familiar with this subject and understand higher mathematical discussions involving differential calculus.

In the introductory paragraph the author discusses the three causes of current change, namely, the dynamo electric, the electromagnetic and the electrical. He then discusses their relative importance in a dynamo and in a motor. The greater part of the book is devoted to a discussion of the short-circuit equation. This he considers first, irrespective of the brush contact resistance, and then includes this resistance, and describes at some length the mathematical solution of the short-circuit equation by Arnold and Mie, which includes the brush contact resistance. This leads to a formulation of the mathematical conditions of sparkless running. The theory is illustrated by some numerical examples using carbon as well as copper brushes, in connection with which he uses certain curves. The next portion of the pamphlet deals with the interchange of energy during commutation, in which use is also made of these curves to explain still further the nature of the process of commutation. The conditons of sparklessness are then discussed and are shown to be three in number, which, however, are to a certain extent inconsistent with one another, and he shows that herein lie many of the difficulties of securing sparklessness. The remainder of the pamphlet deals with the disadvantages of large angles of lead, the application of the results to motors, and the experimental measurement of the current and the interpolar field. A 10-page appendix contains numerical data and constants, which refer to certain curves that he uses.

The author has written considerable on this and allied subjects, such as armature reaction, a long series of articles by him having been abstracted in the Digest of the ELECTRICAL WORLD AND ENGINEER a number of years ago. He seems to be quite conversant with the subject, and the present pamphlet will not fail to be of interest and use to those who wish to study the theoretical side of this difficult question, and who are able to follow the mathematical discussion.

RECENTI PROGRESSI NELLE APPLICAZIONI DELL' ELETTRICITA. Di Rinaldo Ferrini. 3a edizione, completemente rifatta. Milan: Ulrico Hoepli. 283 pages, 109 illustrations. Price, 7.50 lire.

This book is a curious mixture of scientific and popular description, and might be aptly styled "Many Inventions." It appears to be the work of a man who is fond of his subject, and who keeps abreast of the times throughout an extremely wide field. Only the most modern aspects of electrical science and engineering are touched on. The first part is entirely theoretical, and takes up the theory of induction and then gives an exposition of the modern methods for studying periodic currents by means of vector analysis or the algebra of complex quantities. The second part considers the most recent improvements in dynamo design and apparatus used in connection with power plants. The third part is devoted to the more strictly scientific forms of invention and discovery as distinguished from the large applications of power. Thus here are described experiments with polarized light, Röntgen rays, the Marconi telegraph, the Wehnelt interrupter, Hertzian waves, physiological experiments, etc.

BOOKS RECEIVED.

DIE THEORIE DES BLEIACCUMULATORS. Von Dr. Friedrich Dolezalek. Halle: Wilhelm Knapp. 122 pages, 30 illustrations, Price 6 marks.

INSTRUCTION FOR THE USE OF TELEPHONES. United States Signal Corps, U. S. A. Prepared under the direction of General A. W. Greeley, Chief Signal Officer, U. S. A., by Captain Samuel Reber, Signal Corps. Washington: Government Printing Office. 34 pages, 20 plates,

JAHRBUCH FUR ELEKTROCHEMIE. V. und VI. Jahrgango, 1898-9. Von Dr. W. Nernst und Dr. W. Borchers. Halle: Wilhelm Knapp. Volume for 1898, 496 pages and 195 illustrations. Price, 20 marks. Volume for 1899, 431 pages and 204 illustrations. Price, 16 marks.

PRACTICAL ELECTRICAL TESTING. By C. D. Aspinall Parr, Asso. M. E. E. E. London and New York: Longmans, Green & Co. 392 pages, 231 illustrations. Price, $2.50.

N. E. L. A. Convention.

Mr. C. O. Baker, Jr., master of transportation of the National Electric Light Association, writes us: "It gives me pleasure to advise you that the Trunk Line Association, the New England Passenger Association, the Central Passenger Association, the Southeastern Passenger Association and the Canadian lines have granted a rate of a fare and a third on the certificate plan from all points in their territory to Niagara Falls and return, for delegates and friends attending the twenty-fourth convention of this association, to be held May 21, 22 and 23. The time limit of these tickets—three days before and three days after the meeting, not including Sundays—will enable members who desire to do so to attend the dedicatory ceremonies of the Pan-American Exposition at Buffalo, which takes place on Monday, May 20."

Storage Battery Plant of the Cleveland & Chagrin Falls Trolley System.

In order to increase the efficiency of its road the Cleveland & Chagrin Falls Electric Railway Company has recently erected the storage battery sub-station herewith illustrated. The battery installed by the company (Fig. 6) is of the Willard standard type of 400 ampere-hours capacity, the elements being placed in lead-lined tanks large enough to allow the capacity to be raised to 600 amperes by the addition of plates. The plates and elements are lead burned to bus-bars, and at all points where necessary to connect from one group of cells to another, the bars are reinforced with copper. The leads from the battery to switchboard are all of bare copper and covered with lead wherever necessary to protect it from the acid fumes. The tanks containing the elements rest on eight glass petticoat insulators in two tiers. These in turn rest on stringers four by four, which are supported by brick piers built at intervals of every 5 ft. the whole length of the battery room. The battery has a momentary discharge rate of 400 amperes, allowing in extreme cases for discharge rates as high as 900. The circuit breaker on the switchboard is set at this point.

In a room partitioned off from the main battery room is situated the switchboard, which for this type of battery is of very simple construction. The board is of Italian marble, the voltmeter and ammeter being of Weston round pattern, standard type. The circuit breaker is of the I. T. E. pattern, the switchboard switches being furnished by the Graves Electric & Manufacturing Company, of Cleveland.

The battery house (Fig. 7) is a handsome and substantially built brick structure, 30 by 60 ft. The roof is of slate, and the floor is paved with brick. The station is situated at a point 11 miles west of Chagrin Falls and three miles east of Cleveland. The length of the western division of the road from Chagrin Falls to Cleveland being 14 miles.

Before installing the battery a great deal of difficulty was found in operating this division of the road, owing to the excessive drop in the voltage at or near the western terminal. In many cases while operating the regular schedule, the voltage dropped below 200, and it was almost impossible to operate this part of the road if anything

unusual happened, such as the necessity of using a snowplow or running a special car. Since installing the battery, the voltage is maintained between the extreme western end and a point 7 miles east, at an average voltage of over 450, and it does not fall below 350 at any point.

The curves presented herewith were taken from simultaneous readings while a test was being made by the management of the road to ascertain the behavior of the battery while working under maximum load conditions.

Curve 1 (Fig. 1) shows the voltage at the battery while operating under the above conditions, the average voltage being 425.

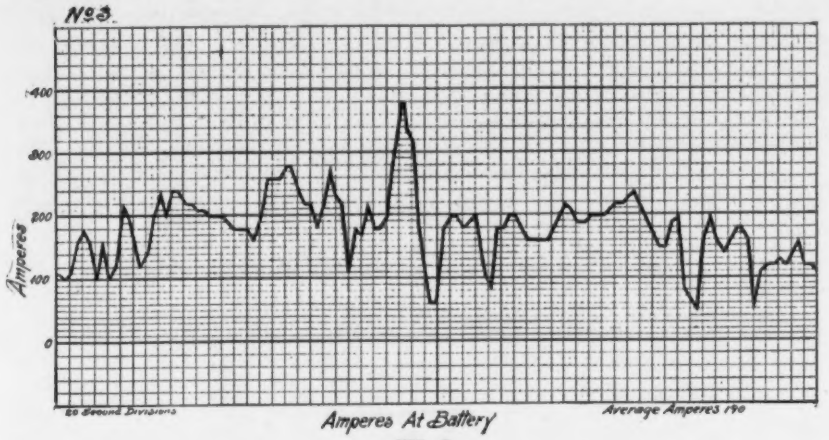


FIG. 3.

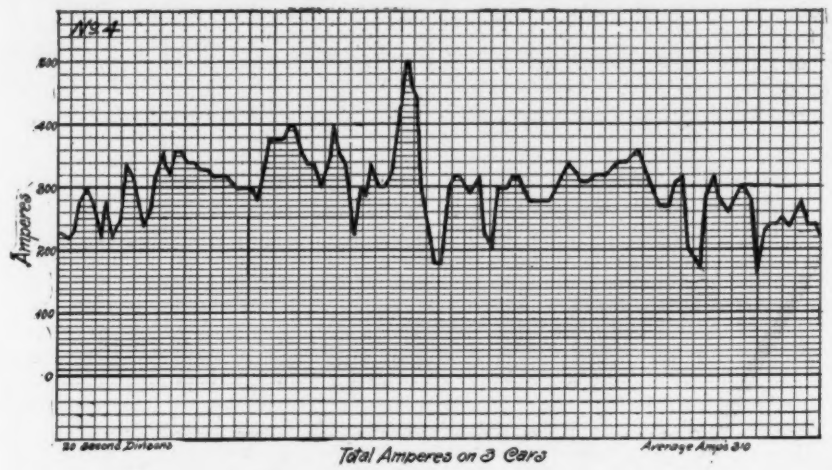


FIG. 4.

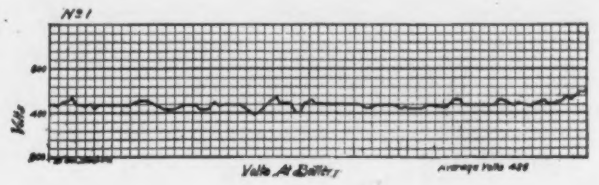


FIG. 1.

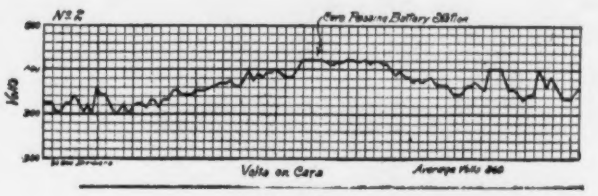


FIG. 2.

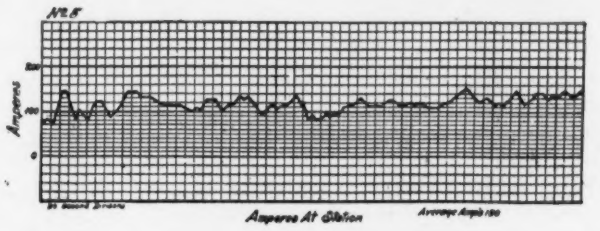


FIG. 5.

tery station, as the drop in voltage would have been so great at times that there would have been no current at all. As stated above, these results were obtained under maximum conditions of load. Under the regular schedule the voltage at a point near the battery is maintained at over 450 volts.

It is claimed that in order to have secured the results obtained through the use of the battery, by the addition of extra copper, the cost of the same would have been nearly three times as great as the cost of the battery, and even then the results would not have been as good had there been any unexpected or heavy demand. It is stated that on several occasions the battery has operated all the cars on the western division for several hours.

It might also be stated that in addition to the work described, the battery furnishes current for 20 or more incandescents used in the

FIG. 6.—STORAGE BATTERY PLANT.

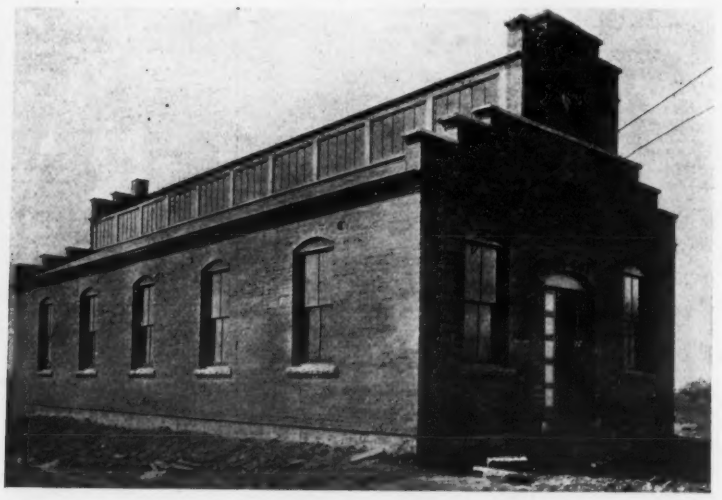


FIG. 7.—STORAGE BATTERY HOUSE.

Curve 2 (Fig. 2) shows the average voltage taken on the cars. In the center of curve No. 2 an arrow is shown to designate the point at which the cars passed the battery station. The voltage on the cars at this point being practically the same as that of the battery. Curve 3 (Fig. 3) shows the ampere readings taken at the battery station. Curve 4 (Fig. 4) shows the total number of amperes

residence and grounds of General Manager Palmer, whose summer home is located a short distance from the station. As evidence of the fact that this station is giving excellent satisfaction, the same company has placed a contract with Messrs. Sipe & Sigler, Cleveland, who furnished the equipment, for a second battery outfit of 265 cells to be placed at Steel's Corners, 14 miles east of the power station. This will be used in maintaining the voltage on the eastern division of the road, including the new extension now being built to Garrettsville. However, instead of floating on the line as in the case of the above battery, the second station will be insalled with an extra feeder to be supplied by a booster at the station.

General Electric Exhibits at the A. I. E. E. Conversazione.

A frequency indicator shown by the General Electric Company at the recent Conversazione of the American Institute of Electrical Engineers, consists of a direct reading instrument, indicating the number of cycles on the circuit to which it is attached. It consists of two fixed coils making a right angle with each other, and a small piece of sheet iron fastened to a shaft mounted in two jewels without springs or other controlling force and moving a pointer over a scale marked in cycles. In series with one of the coils is inductance and in series with the other resistance. When the frequency of a circuit changes the ratio of the two currents in the coils is changed also. The iron blade takes up a position depending on the relative ampere-turns in the two circuits, and this changes the reading on the scale. When the voltage of the line varies both currents vary in the same proportion and therefore the instrument is not affected by change of pressure.

The power factor indicator which was shown is constructed on the principle that in a balanced two or three-phase system, the power factor changes the ratio of watts as found in the two-wattmeter method of measuring the power of the system. This principle has been applied by the General Electric Company in various ways in the construction of power factor indicators. The one on exhibition at the Conversazione had a fixed current coil and two potential coils. The current is led into the movable coils by leads, the controlling force of which is negligible in comparison with that between the fixed coils and the movable coils when the instrument is connected to a circuit. The scale of the instrument is found by actual calibration, that on the instrument exhibited being adapted to rotary converter work with a power factor of one in the middle of the scale and a power factor 90 per cent lagging at one end of the scale and 90 per cent leading at the other.

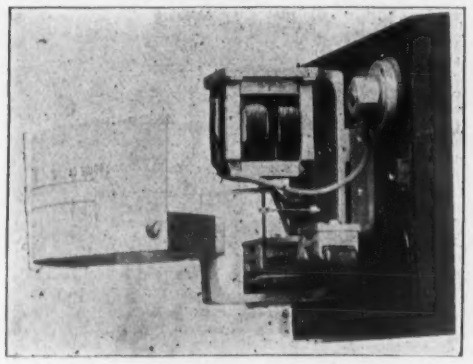


FIG. 1.—FREQUENCY INDICATOR.

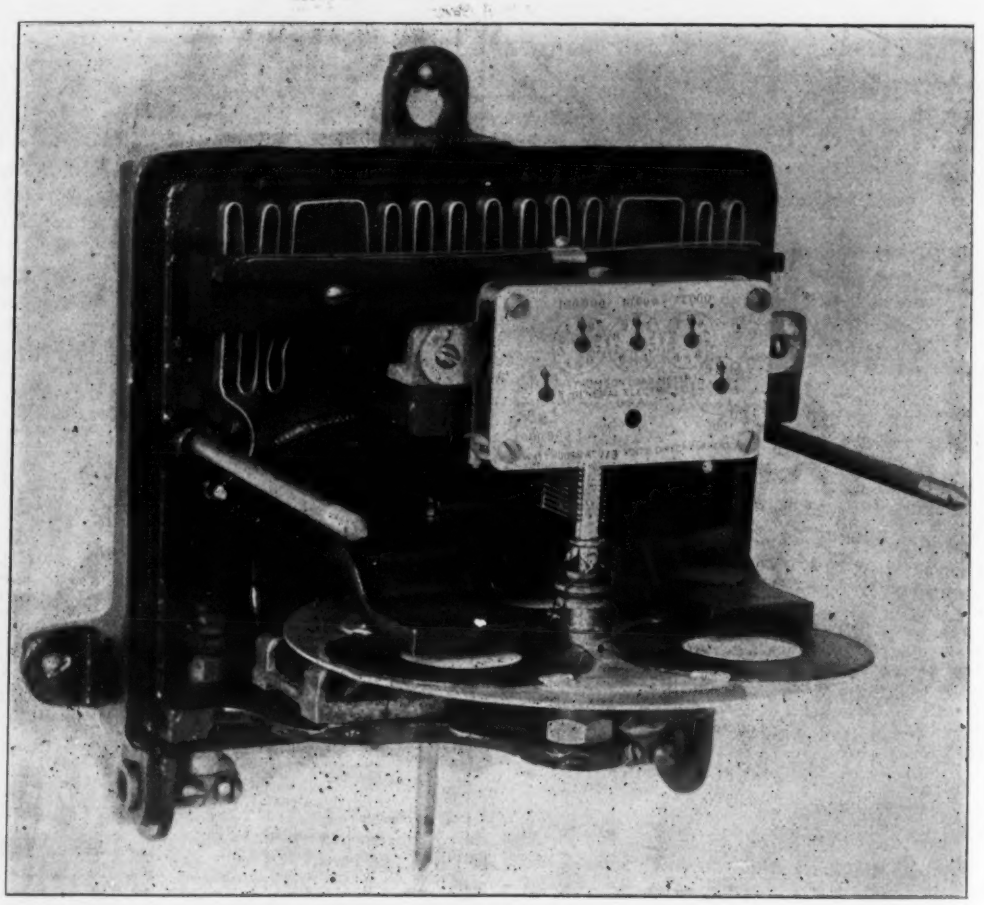


FIG. 2.—LOAD METER.

A wave-form indicator exhibited at the Conversazione is for determining the wave form of e. m. f. or currents, and has been in nearly constant use at the works of the General Electric Company for a number of years. It consists of a contact disk, and a small synchronous four-pole motor, to the shaft of which is fixed a revolving brush which slides over the edge of the disk, the motor being arranged to run without hunting or oscillation. Formerly the disk was attached to the shaft of the generators to be tested, but the great number of poles of large modern machines made it desirable to have an apparatus independent of the angle of one pair of poles. As constructed it is also much more flexible for general use.

The contact device consists of a number of metallic segments on the edge of a hard-rubber disk. They are four large and four smaller segments, each pair consisting of one small and one large segment, the number of pairs corresponding to the number of poles of the small synchronous motor. All the small segments are connected to one terminal and all the large ones to another. When the revolving brush slides over a small segment it connects a condenser directly to the potential difference to be measured, permitting current to flow into the condenser. At the instant at which the brush leaves a small segment, it leaves the condenser charged with the instantaneous potential difference which the circuit had at that instant. The brush then sliding over the large segment closes a circuit consisting of the charge condenser and a direct-current voltmeter, and causes the condenser to discharge through the instrument. These charges and discharges occur four times per revolution and are, with the instrument actually used, at ordinary commercial frequencies sufficiently rapid to produce steady deflection. To the hard-rubber disk is fastened a finger which can be revolved by hand, and by the means of a scale moved every five degrees so as to enable the operator to read off equidistant instantaneous potential differences. A change of condenser capacity or resistance of the instrument does not affect the relative values indicated, as the capacity and resistance are not altered during the test. The deflection on the voltmeter is actually proportional to the instantaneous voltage, as dampening, etc., does not affect the steady deflection. The instrument has given much satisfaction and apparatus made like the model has been in use in colleges, factories and stations.

Astatic instruments have usually been constructed by doubling the movable part either magnet or coil. The Thomson astatic instrument exhibited is constructed on a radically different principle. It is a direct-current instrument, with electromagnets and a light movable coil, which receives the current from its extremely flexible leads, the

torque of which is negligible. The controlling torque of the instrument is due to a piece of magnetic material fastened to the same shaft on which the movable coil is fixed. When the needle points to zero the greater length of the magnetic control piece is in the direction from one pole to the other. When the instrument is connected to the circuit the movable coil receives current and overcoming the controlling force of the control piece causes a deflection.

If the field of the magnet is changed by any cause whatever, the controlling force changes in the same proportion as the deflecting force and the deflection is left unchanged. The instrument shown was of interest on account of an improved arrangement of the magnetic circuits by which four poles of alternate sign were produced by means of one magnetizing coil.

The Röntgen ray exhibit consisted of 12-inch Thomson inductorium sets with a special form of electrolytic interrupter and liquid resistance, in charge of Mr. Westbury. A new form of fluoroscope was shown with a special detachable frame so that the screen could be removed at will, the crystal platino-cyanide of barium being covered with a gelatine cover to prevent deterioration through dust collecting on it. Mr. M. P. Rice, of Schenectady, was to have exhibited a Röntgen ray apparatus, but unfortunately it could not arrive in time.

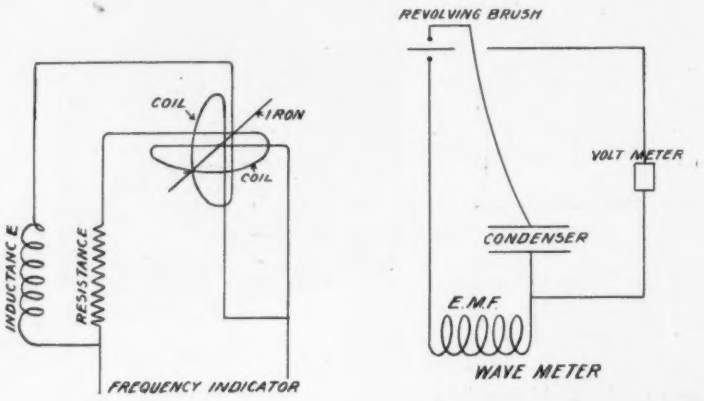


FIG. 3.—DIAGRAMS OF CONNECTIONS.

A Thomson load meter was shown, consisting of a recording integrating device for the commercial measurement of current delivered to continuous current lighting and power loads. Being devised for use upon constant-potential systems of close regulation, it is calibrated in watt-hours. The speed of the meter, however, bears a direct ratio to the current traversing its coils.

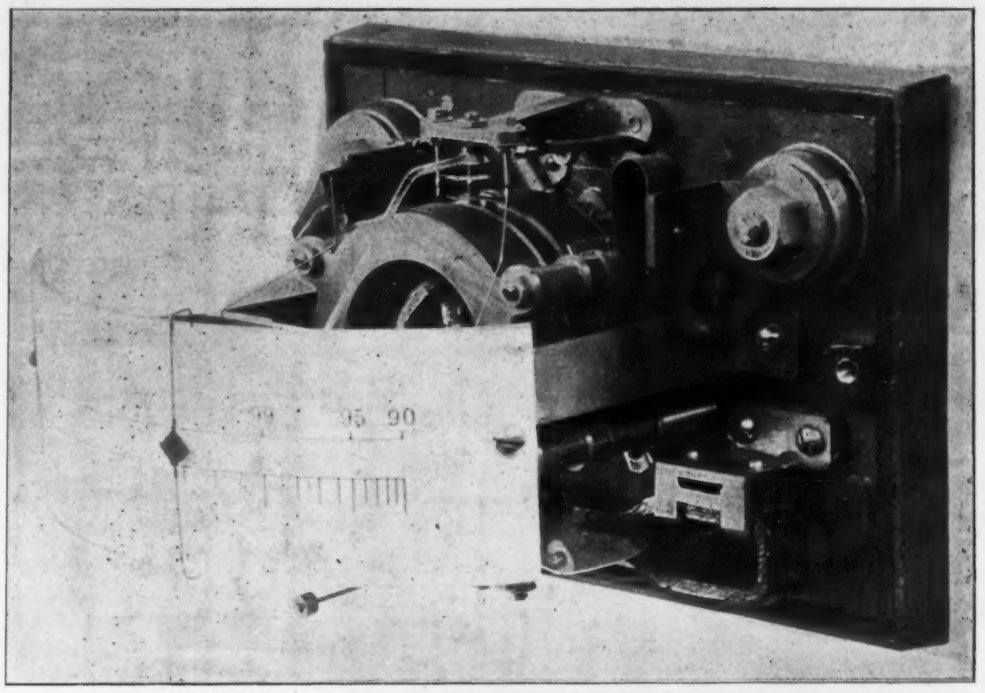


FIG. 4.—POWER FACTOR INDICATOR.

The meter consists in its principal element of an aluminum disk mounted upon a vertical shaft, engaging at the top with a recording train and the lower end of the shaft resting upon an appropriate jewel. The aluminum disk is free to rotate between the jaws of permanent magnets. Upon the aluminum disk are mounted three pancake coils, which constitute an armature, the energy of which is derived through a commutator carried on a shaft or spindle. The armature energy is derived around a fixed resistance contained within the meter, the armature or revolving element thus being in shunt to the resistance. The three pancake coils constituting the armature and physically fixed to the disk, produce torque as in an ordinary motor, the permanent magnets constituting the fields. The same permanent magnets constitute the magnet element of the drag or load, which consists of foucault currents generated in the revolving disk. Friction compensation for light and load operation is provided for by replacing a small electric magnet in such a position as to bring the outer edge of the disk within its jaws. The drag of this magnet increases as the load increases, because the winding is in series with the meter load. The drag is thus less at light loads than at heavy loads, which offsets the effect of the friction.

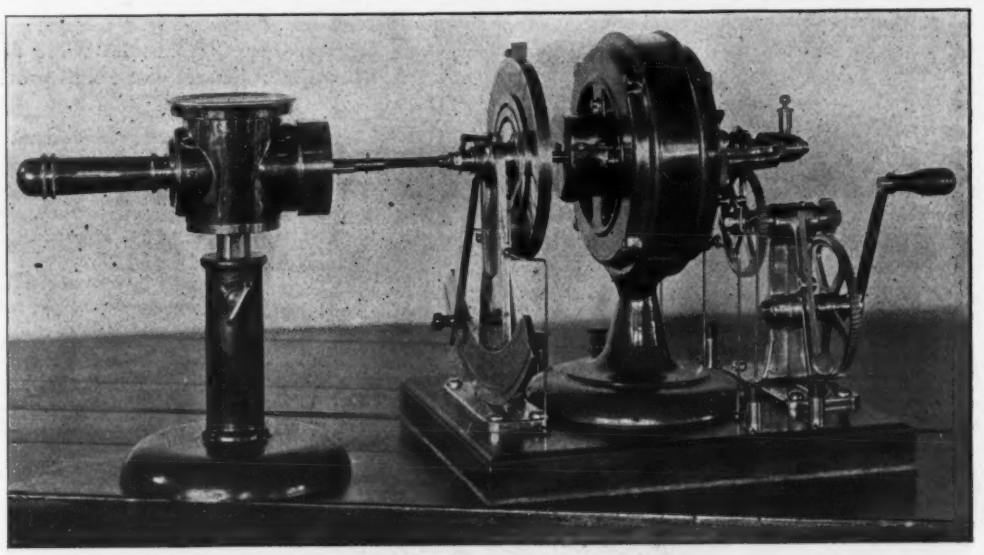


FIG. 5.—WAVE-FORM METER.

High-Voltage Testing Sets.

The accompanying illustrations refer to a method of testing with high voltages, for which apparatus has been devised by the Stanley Electric Manufacturing Company, the object being to provide the extreme pressures required for factory and station tests of insulators, insulating materials, machinery, etc. Many and varied forms of testing sets, for such purposes, have been devised, and as pioneers in alternating-current work, the Stanley Company has had exceptional opportunity for observation of the workings and defects of these. The method described and illustrated is the result of much experience, investigation and experiment on the part of this company's engineers.

Fig. 1 shows, besides the testing outfit proper and a switchboard, a transformer wound to change the supply-line pressure to test-line pressure. The latter is generally 50 or 100 volts. A rheostat is introduced between this transformer and the test line to accomplish any desired further regulation. Leads are taken from the test line, to each of the three special transformers shown, which are introduced into the circuit purely as a precautionary insulation.

The secondaries of each of these transformers are connected in multiple to three individual sets of special oil transformers, changing the test-line pressure from 50 or 100 volts to 10,000 volts. Connecting the secondaries of these 12 transformers in series affords at the end terminals a maximum pressure of 120,000 volts. The advantages of this arrangement are many. The introduction of one set of transformers as a precautionary insulation, precludes the possibility of any accident producing a strain upon the system of the extreme high potentials dealt with. The carrying of the 10,000-volt terminals each to a solid stationary contact post mounted on the terminal board, prevents the possibility of their coming into undesirable proximity.

Between points having a difference of potential exceeding 40,000 volts there intervenes the insulation of four transformers. The path for any such short circuit must, therefore, overcome this insulation, which in each transformer is designed to provide for just such emergencies. Each one is subjected to thorough and severe tests before leaving the factory. Both types of transformers are special transformers, most highly insulated and designed particularly for this special use and arrangement. Fig. 2 shows one of the 12 high-voltage transformers, and Fig. 3 the coils of the same; Fig. 4 the spark-gap.

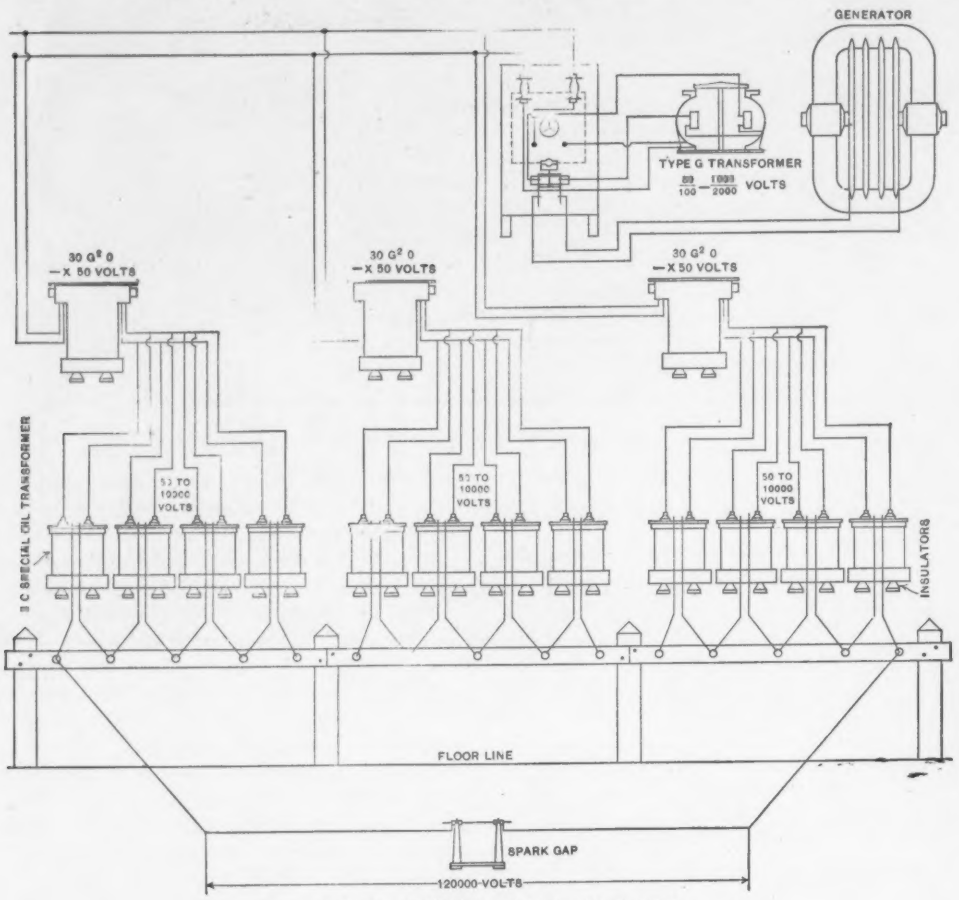


FIG. 1.—DIAGRAM OF TESTING OUTFIT.

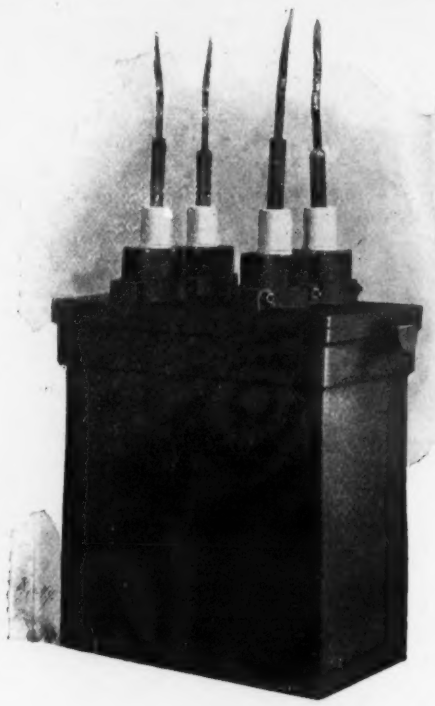


FIG. 2.—TRANSFORMER.

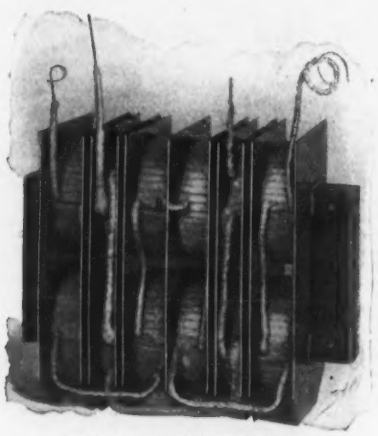


FIG. 3.—TRANSFORMER COILS.

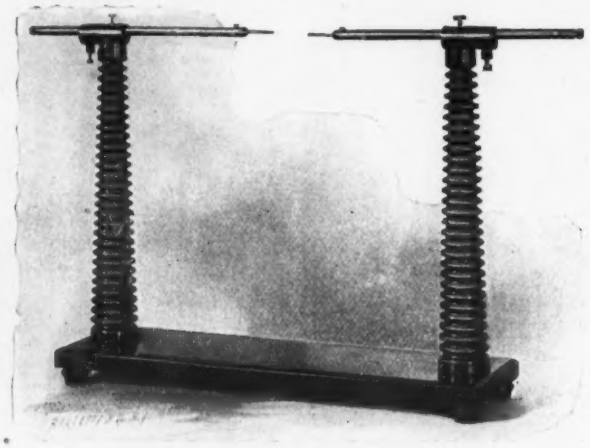


FIG. 4.—SPARK-GAP.

The test leads are flexible and may be attached to any of these contact posts, thus providing an adjustment of steps of 10,000 volts from 10,000 to 120,000 volts, intermediate variations to be effected by the rheostat. These flexible terminals should be of standard manufacture highly insulated. It is not contemplated that they will be handled while alive. Before making adjustments, the main switch should be opened. Both sets of transformers should be thoroughly insulated from the ground by means of wooden blocks, and glass or porcelain insulators. Should one of the oil transformers from any mishap fail, it is but a simple mater to bridge the secondary terminals and disconnect the primary terminals of the same and operate at the reduced voltage until repairs can be effected.

If a local generator, accessible for desired regulation is to be the source of supply, the test line may be taken direct from the generator. That is, the required voltage will be furnished without the intervention of a transformer, voltage variations in such instances being effected in the generator.

The spark-gap (Fig. 4) is used virtually as a voltmeter, and the curve in Fig. 5 gives the voltages at which the sparking should take place from 50000 to 150,000 volts. The spark-gap is designed to withstand the tremendous voltages to which it will, in practice, be subjected. The base is 18 inches by 5 inches of best quality hard rubber, three-quarters of an inch thick; the edges are beveled and the whole is neatly and substantially put together. Extra insulation is provided by the four legs or supports. The posts carrying the

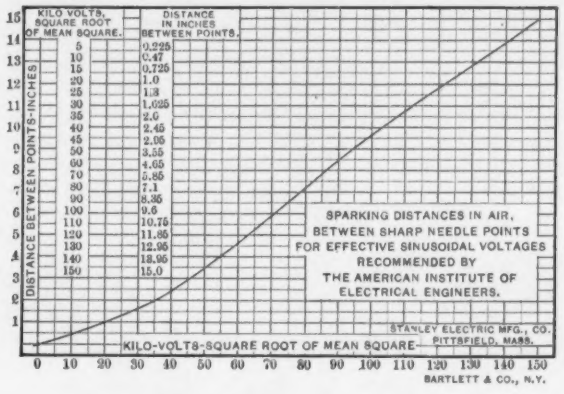


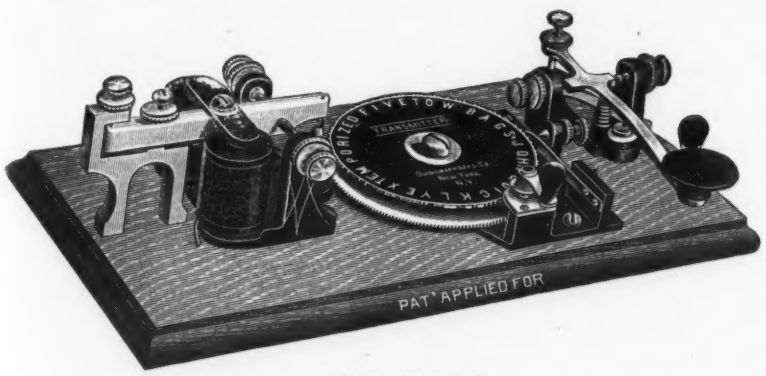
FIG. 5.—CURVE OF SPARKING VOLTAGES.

adjustable terminals are of a form offering the greatest creepage resistance. They are also of best quality hard rubber, and the whole will successfully withstand a pressure many times that for which designed. Fig. 5 is a curve showing the relation between voltage and sparking distance.

The only other feasible apparatus for the production of high testing voltages is the single transformer. These have been built to supply such pressures, but they are expensive, unwieldy affairs, and to be avoided if possible. There is no comparison between the single great transformer and the combination of units herein described, which affords a flexible and portable outfit possessing all the qualities to be desired.

An Improved Telegraph Teaching Instrument.

The "Omnigraph" illustrated herewith is designed to assist students of telegraphy in learning to read by sound. In connection with the key and sounder of a regular learner's outfit is arranged a type disk of brass which is operated by a small crank geared thereto. On the circumference of the brass disk are cut the dots and dashes corresponding to the letters of the alphabet, and as the disk is revolved the characters on its periphery come into contact with a stationary spring contact point. Since the disk and contact point are in circuit with the sounder the effect is to reproduce the characters on the sounder, thus enabling the student to acquire practice in receiving. For sending practice it is necessary to close the circuit by allowing the contact point to remain in contact with any one of the



THE OMNIGRAPH.

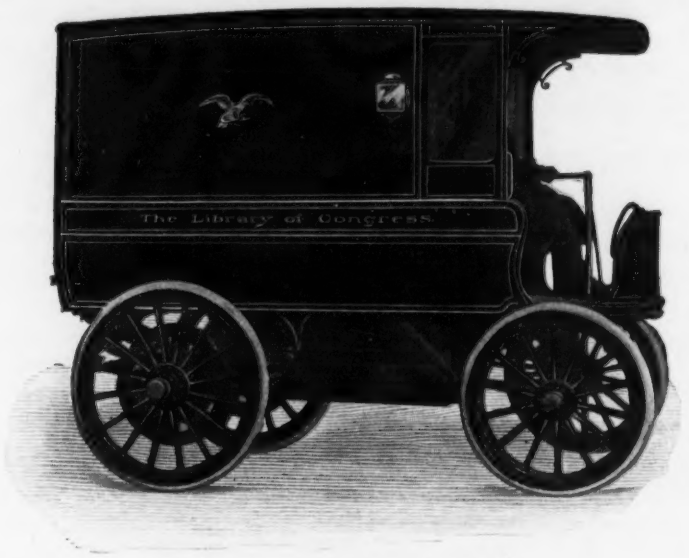
characters on the periphery of the disk, and then use the key in the usual manner, the sounder, disk, contact point and key all being connected in series.

The characters and spaces on the disk are of correct lengths, hence the student hears the characters accurately formed, which is not the case when they are transmitted by hand on the key.

This instrument is manufactured by the Omnigraph Manufacturing Company, 39 Cortlandt Street, New York. At the present time the disk is provided with the sentence, "John quickly extemporized five tow bags," which contains all the letters of the alphabet, but it is the company's intention to provide interchangeable disks with the letters of the alphabet and the numerals in regular sequence, and the punctuation marks.

Automobile for the Library of Congress.

Concerning the type of Columbia delivery wagon, which has recently been sold to the Government for the distribution of books from the Congressional Library, the manager of the Washington Electric Vehicle Transportation Company reports as follows: "Before the Library people purchased this vehicle, they sent out circulars asking for bids from all the different manufacturers. They also investigated the subject very closely, and while our vehicle was the highest in price, still the contract was awarded to us. The fact that



ELECTRIC LIBRARY DELIVERY WAGON.

we have vehicles of this type and other types running successfully in Washington had great weight in the matter. The Library people have been operating this vehicle themselves for the last month, and are very much pleased with it, and we have every reason to believe that this is but a forerunner of a number of vehicles which we will be able to sell to the Government."

Another Columbia vehicle of this type is under contract to carry the mails between the Buffalo Post Office and the Pan-American Exposition grounds.

A New Method of Silvering Searchlight Mirrors.

The greatest drawback in the employment of strong focus lenses and high-current values in searchlights at the present time is the short life of the common silver backing of the mirrors. It is found that with a coating of pure silver, even though it has a thickness of but a few hundred thousandths of an inch, the difference in ratio of expansion causes the silver to peel off in a short time if the glass is heated much over 175 degs. Fahr. The Rushmore Dynamo Works, which make a specialty of lens projectors and claim the largest lens making plant in the world, have perfected a new process of silvering their lenses and have produced a silver-platinum backing that is stated not to be affected by any degree of heat.

The metal film in direct contact with the glass is of pure silver, and is but a few millionths of an inch thick, so thin, in fact, that when held to the light it is transparent and simply gives a bluish tinge to the glass. On the back of this thin film of silver there is deposited by a new process a coating of a new compound which contains 90 per cent of platinum. The platinum having nearly the same coefficient of expansion as glass, it always maintains perfect contact with the glass at all temperatures. While the combined thickness of the silver and platinum alloy is extremely small, it is heavy enough

to resist any disintegrating action of the protective compound used as a backing for the mechanical protection of the metal coating.

On a recent test a lens silvered by the new process was heated almost to the melting point of the glass without any effect upon the silvering. The platinum coating may be deposited directly upon the glass, but it has been found that the silver produces a more brilliant surface and does not in any way interfere with the heavier backing metal.

Improved Electric Signs.

There has been on exhibition recently in the Knickerbocker Theater building in this city a new system of electric sign construction that possesses some interesting features. The invention comes from England, and is controlled by the Electric Lighting Boards, Limited, of London, the system being known as the E. L. B. system.

CONNECTING-UP LAMP.

The unique feature of the system is that of an electric sign or a design of any sort may be made up at once without any preparation or special wiring, by simply pressing the lamps into the surface of the board wherever it is desired to locate them. The signboards may be made of any size and shape. They are constructed in the following manner: Upon a backing of wood or similar supporting material is placed a sheet of asbestos covering the entire surface of the board. On the asbestos is placed a layer of rubber and on top of that the bare stranded copper ribbon conductors laid in equidistant parallel lines. Between the conductors is placed a strip of hard fibre as a spacing piece as well as an insulator, and on top of the conductors and fibre strips is laid anothre sheet of rubber, and above this a sheet of asbestos. On top of the asbestos is placed a layer of a composition composed of ground cork and heavy oils, which forms the exterior front surface of the board. This cork composition, which is 3-16 inch thick, is quite elastic and acts as the support for the lamps when they are placed in position. By pressure the conductors are shaped into the form of ribbons ½ inch wide, the thickness of the fibre insulating wall between them being ⅛ inch. Since the conductors are arranged in lengths parallel to one another, and connected up as branches from the supply wires, it is evident that practically the entire surface of the board is "alive."

The lamps have a special base, the outer terminals of the leading-in wires consisting of two prongs or needle points, about half an inch apart. It is evident that by sticking a lamp almost anywhere on the surface of the board the prongs will penetrate the strands of two adjacent conductors and thus close a circuit through the lamp. It may happen that in inserting the prongs a fibre strip is encountered. All that is necessary in such cases is to pull the lamp out and press it home again in a new position, which can never exceed ⅛ of an inch from the first one. The conductors may be run horizontally or vertically, it makes no practical difference how. In either case, continuous connecting surfaces are available in the direction in which the conductors run, and practically continuous surfaces at all angles therefrom. It will thus be seen that a lamp may be placed in circuit practically anywhere on the board by simply pressing its prongs through the surface into the stranded conductors.

The shape of the board is immaterial. It may be in the form of a narrow molding with two wires, or square, oblong, etc., with any number of parallel branches from the two supply wires. There were shown examples of various uses to which the invention can be applied, including moldings, flexible strips for decorating purposes and for sign letters, advertising boards, etc. In all, the central feature is the possibility of placing lamps where needed, without special wiring or the installation of sockets or other special appliances.

A novel application of the system is in using a board of the proper dimensions as the top of a desk or table. This permits the placing of a lamp standard anywhere on the table or desk, almost as easily as moving an oil lamp about. The extreme flexibility of the system renders it specially useful for temporary decorations, illuminations, etc.

A New York syndicate has purchased the American rights and will exploit the invention.

Electric Stanhope Phaeton.

The Baker Motor Vehicle Company, of Cleveland, Ohio, whose electric runabout has been illustrated in these columns and which has attracted widespread attention and much favorable comment at the various motor vehicle exhibitions, is bringing out, as a companion to the runabout, the Stanhope phaeton herewith illustrated. It was especially designed in answer to a demand for a light vehicle which can be handled by a lady; in fact, the original vehicle of this pattern was designed for the use of Mrs. W. C. Baker, who is an enthusiastic operator. The mechanical equipment of the vehicle is practically the same as that of the runabout. It has a 1-hp motor, and is equipped with 10 cells of battery, giving, it is claimed, a radius of 20 miles over average city roads on one charge. There are three speeds, forward and back, the reverse being controlled by a lever under the foot.

The highest speed of the motor gives about 15 miles an hour,

STANHOPE PHAETON.

and on the first speed there is a choke coil which avoids the sudden jar in starting. The speeds are controlled by one handle, which also controls a brake on the motor shaft. There is also a powerful foot brake operating on the differential gear. The motor is hung under the center of the body, and is protected by a dust and water-proof covering. The steering lever is of the side-steering type. The vehicle is finished and upholstered in the best manner. Ball bearings are used throughout. The running gear is tubular, except the side reaches, which are hickory, enameled, giving extreme flexibility and insuring easy riding. The carriage complete weighs 800 lbs., and, as will be seen by reference to the illustration, is light and neat in appearance.

Rogers Telegraph Apparatus.

The Rogers Electrical Works, of 55 Dey Street, are a corporation putting on the market a line of telegraph instruments and specialties which they are manufacturing under patents issued to Ulysses G. Rogers. Among the instruments are pole-changing devices, switches and cut-outs. One of the specialties is a standard pony relay of very rigid construction. The frame to which are attached the front and back contacts passes down between the magnet coils, and is milled to conform to the curve of the coils. The metal parts are finely finished. The spools have polished rubber covers. The base is of mahogany with a japanned surbase. Another instrument is their improved learners' telegraph outfit, comprising steel level key and sounder.

The key base, the sounding lever, yoke, etc., are of a finely finished composition, there being no painted cast iron used in the construction. The sounder gives an extraordinarily clear sound, with minimum amount of current, while the contacts are located on the top and the bottom of the key, which permits the use of a dry or any other type of open circuit battery in connection with the instruments.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Money closed at 3 per cent nominally. Time money was quoted at 4 per cent for 30 days to 4 months, and 4½ per cent for 5 and 6 months. Mercantile paper was quiet throughout the week, the closing price being 4 per cent for 60 to 90 days' indorsed bills receivable, 4@4½ per cent for choice 4 to 6 months single names and 5@6 for others. The stock market continues strong, active and excited, with heavy manipulation in prominent stocks and extensive public participation in speculation. On Friday, April 19, all previous records in stock transactions were broken, the number of shares sold on that day having reached the enormous number of 2,200,000. All records of bank clearings were also broken last week, aggregating $3,047,934,602, a total of 15.2 per cent higher than the largest previous weekly total recorded—that for the second week in January, this year. Compared with last week there is an increase of 21 per cent, and over the same week a year ago there is a gain of 77 per cent. Outside of New York, clearings were 10.7 per cent larger than the week previous, and one-third larger than the same week a year ago. New York clearings for the week were just double those of a year ago. There was considerable activity in traction stocks, with advancing prices. Metropolitan Street Railway closed with a net gain of 5½ points, the sales for the week amounting to 141,868 shares. Brooklyn Rapid Transit made a net gain of 3¼ points, the sales being 121,245. In the electric list, General Electric slumped 3 points, the sales being 5250 shares. The tendency of Western Union continues upwards and at the close of the week the stock was 1¼ points above the closing figure the previous week. There was considerable activity, the transactions amounting to 60,430. The curb market on Saturday made little response to the enormous activity shown on the Stock Exchange, most outside issues remaining dull, with irregular price movements. There was a movement in General Carriage which carried the stock up to 2¾, and at the close 2½ was bid, a net gain of ½ point. Following are the closing quotations at New York, Boston and Philadelphia, the absence of Chicago quotations being due to the derangement of telegraph wires by the storm:

NEW YORK.

	Apr. 13	Apr. 20.		Apr. 13.	Apr. 20.
General Electric	226½	223½	Electric Vehicle	12	12
Brooklyn Rapid Transit	83½	86¾	Electric Vehicle, pfd	20	20
Metropolitan Street Ry	168½	174	General Carriage	2	2½
American Tel. & Cable	100	100	Illinois Elec. Veh. Tran	⅜	⅜
Western Union Tel	92½	93¼	Hudson River Tel	120	—
American Dist. Tel	36*	—	N. E. Elec. Veh. Tran	2½	2½
Commercial Cable	170	179	N. Y. Elec. Veh. Tran	5½	4½
Electric Boat	21	17	Tel. & Tel. Co. of Am	5	5
Electric Boat, pfd	50	47	N. Y. & N. J. Tel	160	—
Electric Lead Reduc'n	4½	4½			

BOSTON.

	Apr. 13	Apr. 20.		Apr. 13.	Apr. 20.
New England Telephone	141	—	Erie Telephone	61½	60
Mexican Telephone	3	3	General Electric, pfd	—	—
Westinghouse Electric	—	—	Am. Tel. & Tel	171	176½
Westinghouse Elec., pfd.	—	—	Boston Electric Light	—	—

PHILADELPHIA.

	Apr. 13	Apr. 20.		Apr. 13.	Apr. 20.
Electric Storage Battery	75	69¾	Philadelphia Electric	6⅜	6⅜
Elec. Storage Bat., pfd	75	74	Pa. Electric Vehicle	1	1¼
Elec. Co. of America	8¾	9⅜	Pa. Elec. Veh. pfd	¾	1
General Electric Auto	—	—	Am. Railways	40	42¼

CHICAGO.

	Apr. 13	Apr. 20.		Apr. 13.	Apr. 20.
Chicago Edison	154	155	Chicago Telep. Co	230	—
Chicago City Ry	257	—	Union Traction	15	—
National Carbon	15¾	—	Union Traction, pfd	57	—
National Carbon, pfd	83	—	Northwest Elev. Com	40	—

*Asked.

DIVIDENDS.—The directors of the Columbus, Ohio, Railway Company have declared the regular quarterly dividend of 1¼ per cent on the preferred stock, payable May 1. The directors of the Bell Telephone Company, of Philadelphia, have declared the regular quarterly dividend of 2 per cent. The Cincinnati, Newport & Covington has declared the regular quarterly dividend of ¾ of 1 per cent, payable May 1. The directors of the General Electric Company have declared the regular semi-annual dividend of $3.50 per share on the preferred stock, payable August 1, to stock of record June 15. The directors of the Westinghouse Electric & Manufacturing Company have declared the regular quarterly dividend of 1½ per cent upon the assenting stock of the company payable May 15. The Edison Electric Illuminating Company, of Boston, has declared a quarterly dividend of 2½ per cent. The previous quarterly dividend was 2 per cent and 1 per cent extra. The Denver City Tramway Company has declared a quarterly dividend of 1 per cent upon its capital stock, payable May 15. The regular quarterly dividend of 2 per cent on the preferred stock of the American Graphophone Company will be paid on May 15.

ELECTRIC COMPANY OF AMERICA.—Mr. W. J. Latta has resigned from the board of the Electric Company of America, following the lead of Martin Maloney, who retired some time ago. Clement A. Griscom, president of the International Navigation Company, has been chosen to fill the vacancy. The full board will be: W. L. Elkins, P. A. B. Widener, Thomas Dolan, H. T. Hartman, Clement A. Griscom, C. A. Porter, A. Loudon Snowden, Joseph B. McCall and James E. Hays. A director of the company says: "The annual report will make quite a favorable showing. We are well supplied with funds and no call is in sight." The extension of the Atlantic City lighting system to Chelsea and Ventnor, N. J., will require poling and wiring, which will be paid for, it is stated, with money on hand. About one hundred of the stockholders attended the Electric Company of America annual meeting. The statement showed $410,695 net profits for the year ended Dec. 31, 1900. The profit from operation of plants in 1900 was $374,538 and other income $36,156. A year's dividend is $1 per share on 406,281 shares outstanding. The net profits from operation of plants in 1899 were $407,975, and the income from other sources $633,359. The general balance sheet as of Dec. 31, 1900, shows total assets of $3,810,819, and a profit and loss surplus of $742,045.

ERIE TELEPHONE.—During the past 17 years the Erie Company has paid 69 dividends, the last one being at the rate of 1¼ per cent quarterly. During this time the company has raised $28,000,000 for construction purposes, putting in with this money 137,000 telephone stations, 95,000 miles of long-distance lines, and 60 telephone buildings, as well as 95,000 miles of exchange wires underground, out of a total wire mileage of 300,000.

KANSAS CITY.—The Metropolitan Street Railway Company, of Kansas City, has bought out the East Side Electric Railway, a short trolley line promoted and partly owned by men interested in the Ferd Heim Brewery, for $250,000. It now gives the Metropolitan Company a complete monopoly of the street railways of Kansas City.

GENERAL ELECTRIC STOCK.—The General Electric Company informs holders of its 7 per cent cumulative preferred stock that the company will give them common stock for it share for share. The common stock is now on an 8 per cent basis.

B. R. T.—The sale is noted to a syndicate by the Brooklyn Rapid Transit Company of $3,111,000 Brooklyn Union Elevated 4-5 per cent gold bonds, authorized betterments, improvements and for equipping the system with electricity.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports to the mercantile agencies indicate that trade developments in the main are favorable, the exceptions being in the Central West and part of the Northwest, where cold, rainy weather prevails, restricting distributive trade. The great volume of general business and the enormous size of financial operations now proceeding are reflected in record-breaking clearings, not confined, however, to speculative centers but reported from all sections of the country. Current gross railway earnings remain favorable. Though the ratio of gains is not as great as in recent preceding weeks, net earnings are very good and furnish ample basis for some excited movements in securities. All sections of the country show gains, the most remarkable being the increase of 53 per cent in the coal roads, of 28.6 per cent on the Southwestern lines, of 19 per cent by the Eastern roads, and of 18.6 per cent by the Southern lines. The smallest gain in the net earnings is 4.2 per cent, contributed by the Central Western roads. *Bradstreet's* reports the number of failures for the week as 212, against 225 last week and 161 the corresponding week last year. R. G. Dun & Co. compute the liabilities for the two weeks of April at $2,493,075, against $4,865,470 the corresponding period last year. In the metal market Lake Superior copper ingot is quoted at 17 cents and electrolytic at 16⅝ cents. There was no quotable change in either price, and in certain quarters of the trade electrolytic is held with more firmness.

THE THRESHER ELECTRIC COMPANY, of Dayton, Ohio, has been incorporated under the laws of the State of West Virginia, with an authorized capital of $600,000, for the manufacture and sale

of all kinds of electrical machinery and appliances. This corporation succeeds the company of the same name of which Mr. Alfred A. Thresher has been the sole proprietor, and which he has incorporated for the purpose of providing more ample facilities for conducting the large and growing business which has been built up during the past eight years under his individual management. Mr. Thresher is a member of the American Institute of Electrical Engineers, and of the Franklin Institute of Philadelphia, an associate member of the Society of Naval Architects and Marine Engineers and a graduate of Denison University. After graduation, he spent more than a year abroad in travel and observation, and soon after his return established the business which he has prosecuted to the present time, overcoming all the obstacles incident to a new enterprise with persistent energy, determination and ability. In thus adding to the list of Dayton's successful manufacturing enterprises, it has been the aim of Mr. Thresher in addition to obtaining the discipline and knowledge of details, requisite to the conduct of any successful business, to also gain such a grasp of practical mechanical knowledge as well as a personal acquaintance with the requirements of purchasers as would fit him to design and construct the highest grade of electrical machinery. In entering the general market, the Thresher Electric Company offers three complete lines of direct-current apparatus for electric railways, lighting and power transmission, viz., generators, both direct connected and belted, of the most approved design, exact in regulation under all degrees of load and economical in operation; a complete system of motors for the transmission and application of electrical power to the varied requirements of industrial uses, including an entirely enclosed type giving very high efficiency combined with complete protection; and marine generating sets, of highest efficiency, designed to meet the severe requirements of the government naval service. It will be remembered that in a recent article we showed a vertical type of generator of original design, to be run direct connected to the shaft of a turbine. Plans are being prepared for extensive shops with a complete equipment, affording the most approved facilities for manufacturing and testing.

TRADE IN SOUTH AFRICA.—A merchant at the Cape writes thus to a friend at Wolverhampton, England: The ultimate result of all this tumult will no doubt be a very great expansion of trade, not only for England, but for other countries, and if the British manufacturers don't mind what they are about they will be beaten out of this market in many things. America, Germany, Canada, Australia and other countries are sending out representatives and appointing resident agents to work up business direct with the buyers here and in the other colonies. These agents are well paid, they are liberally supplied with samples, catalogues and other means for making the goods known. The manufacturers ship the goods and draw for value through bankers at 30 to 90 days' sight direct on the customers. British manufacturers (with a few sensible exceptions) consider they are safer in doing their business through the old-fashioned way of the London merchant; but those who have tried the direct way will never go back to the old way. Even in the simple matter of correspondence, America and other countries set England an example, not only in manners, but in wisdom, and this is a complaint I have heard from several good firms in this city: "That English houses are not only dilatory in replying to letters, but in many cases do not reply at all." I have written to scores of firms in America, Australia, Germany, France and other places, and even when there was no probable chance of doing business I have never failed to get a courteous reply, giving all the information available.

STEEL RAIL PRICES.—It is stated that within a week the price of steel rails will be advanced from $26 to $28 a ton. A meeting has been called for this week at which members of the pool will take action on an advance in price. The increase, it is stated, will take effect on May 1. The tonnage of steel rails placed so far this year exceeds that of any year in the history of the trade. It is estimated that since the pool made the price of rails last fall, orders for more than 2,000,000 tons have been placed. Advances in prices have been made by other steel and iron pools in billets, beams and plates, but as yet no advances in rails have been made nothwithstanding the higher prices for pig iron and other raw forms. Billets, beams and plates have been advanced on an average of $6 a ton, while pig iron is now selling at prices considerably higher than when the prices for rails were announced. All the large rail mills are filled to their utmost capacity.

CASE CRANE SALES.—The Case Manufacturing Company, of Columbus, Ohio, reports the following list of crane sales made recently: Lewis Foundry & Machine Company, Pittsburg, one 20-ton 50-ft. span; Hoeffinghoff & Lane, Cincinnati, Ohio, one 25-ton 46-ft. span; Carnahan Tin Plate & Sheet Company, Canton, Ohio, one 15-ton crane; Camden Iron Works, Camden, N. J., one 30-ton 56-ft. span; Niles Boiler Company, Niles, Ohio, one 10-ton 47-ft. 6-inch span; W. S. Tyler Company, Cleveland, Ohio, one 5-ton electric hoist; Weiskittle & Son, Baltimore, Md., one 3-ton 3-motor crane; William R. Trigg Company, Richmond, Va., one 3-ton 32-ft. span 3-motor crane; United States Cast Iron Pipe & Foundry Company, one 25-ton crane; Natural Food Company, Niagara Falls, N. Y., two 1-ton traveling cranes; James Leffel & Co., Springfield, Ohio, one 15-ton 50-ft. span.

ENGINE BUILDERS CONSOLIDATION.—It is reported that Vermilye & Co. are the bankers behind a projected combination of manufacturers of stationary and mining engines. According to reports the negotiations have reached an advanced stage, and it is proposed to combine these five firms: Pennsylvania Iron Company, E. P. Allis Company, Milwaukee; Frazer & Chalmers, Chicago; Gates Iron Company, Chicago, and Dickson Manufacturing Company, Scranton, Pa. Of the proposed capital of $25,000,000, it is said $1,000,000 of 7 per cent cumulative preferred stock of the new company was offered for the Pennsylvania Iron Company's plant and fixed assets. There is still a good deal of verbiage and vagueness about the transaction. It will be noted that several big concerns are not in the proposed deal.

SARATOGA TROLLEYS.—Joseph J. Powers, of Troy, and ex-State Treasurer Addison B. Colvin, of Glens Falls, have purchased the control and assumed charge of the Saratoga Traction Company. These gentlemen, with John W. Herbert, of Helmetta, N. J., are extensive trolley managers in New York State and Canada. The new purchase includes the beautiful park opened late last season, Saratoga Lake and the race track terminals. It will become a feature of the Powers-Colvin system of Hudson Valley roads, and with the Stillwater and Mechanicsville, Greenwich and Schuylerville, Saratoga and Northern and Warren County railroads, owned by these men, it will in time afford an opportunity for frequent and rapid transportation of persons and freight between all the cities, villages and towns from Albany and Troy north to Warrensburg.

CONSOLIDATION OF CHATTANOOGA TROLLEY.—Messrs. Clarence P. King and J. H. Jeffries, of Philadelphia, who own the controlling stock of the Chattanooga Rapid Transit Company, have been there for the purpose, it is said, of finally taking possession of the lines reaching Lookout Mountain, including the two inclines, the Lulu Lake broad-gauge and narrow-gauge roads. This deal has been hanging fire on a technicality for some time. It is also said that the Rapid Transit people will close the deal by which that company will absorb the Chattanooga City Electric Railway Company's plant. The consolidation of these lines will merge the electric railways of Chattanooga into one system capitalized for over a million dollars.

THE TRINIDAD ELECTRIC LIGHT & POWER COMPANY, West Indies, is at present making some purchases in this market for the additional equipment of its plant at Port au Spain. The Harrisburg Foundry & Machine Works, of Harrisburg, Pa., whose local offices are in the Mail and Express Building, 203 Broadway, are to build a 300-hp horizontal compound engine. A 200-kw belted generator has been ordered of the General Electric Company. The Trinidad plant at present develops 2,000 horse-power. The engines and generators were furnished by the above mentioned concerns. Further contracts are expected to be placed very shortly.

TARIFF ON MACHINERY IN DUTCH INDIA.—Consul Hill sends from Amsterdam, March 12, 1901, a statement of the tariff of the Netherlands East Indies. The tariff rates are as follows: Factory and steam engines, machinery; machines and tools for agricultural, factory and steam purposes, mining and trades, and also parts thereof, if considered so by the custom house officers free. Iron, ironware, cast, wrought, milled or forged, not separately specified, 10 per cent ad valorem.

POWER FOR BINGHAMTON.—A project is under way to dam the Susquehanna River, two and one-half miles below the junction of the Susquehanna and the Chenango, near Binghamton, N. Y., the intention being to install an electric-power generating plant for the use of the city. The proposed dam will be of great sanitary as well as industrial benefit to the city, the three miles of back-water flooding shallows where now sewage collects.

COLORADO FUEL & IRON COMPANY, of 71 Broadway, New York City, is adding to its equipments in the West, and is enlarging its power plant. Two Westinghouse 500-kw, 220-volt generators have been ordered, direct driven by an Allis compound condensing engine. Worthington surface condensers have also been ordered, and boilers added.

THE CHARLESTON EXPOSITION.—J. L. Malcomson, chief engineer of the electrical and motive power departments of the Charleston International & West Indian Exposition, has been in Cincinnati, placing orders for machinery and supplies required in his department. As a result of his visit, the Bullock Manufacturing Company will have a handsome display there.

ELECTRIC FOUNTAIN.—The promoters of the Fall Festival Association, at Cincinnati, which will hold its second annual celebration September 16-28, are contracting for an electric fountain. It will become a permanent ornament to the city.

W. B. COWLES & CO., of Cleveland, Ohio, are installing two 75-hp engines built by the Ball Engine Company, of Erie, Pa., in the Power building in that city.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical material from the port of New York for the week ended April 3: Antwerp—9 cases electrical material, $863; 2 cases electrical machinery, $149. Berlin—18 packages electrical material, $600; 7 packages electrical machinery, $3000. Brazil—18 packages electrical material, $811; 3 packages electrical machinery, $1845. British Guiana—61 packages electrical material, $5,128. British West Indies—10 packages electrical material, $122; 2 packages electrical machinery, $400. British East Indies—261 cases electrical machinery, $4,275. Cuba—84 cases electrical material, $1,240. Chili—1 package electrical material, $19. Central America—12 packages electrical machinery, $684. Dutch West Indies—1 package electrical material, $12. Ecuador—1 package electrical material, $27. Genoa—79 packages electrical material, $18,970. Havre—168 packages electrical machinery, $22,622; 26 packages electrical material, $1,231. Hamburg—18 packages electrical material, $608; 6 cases motor vehicles, $1,800. Hayti—2 packages electrical material, $51. London—71 packages electrical machinery, $6,551; 110 packages electrical material, $5,947; 21 packages motor vehicles and parts, $14,000. Liverpool—70 packages electrical machinery, $7,767; 26 packages electrical material, $2,034. Manchester—41 cases electrical machinery, $10,365. Mexico—64 packages electrical material, $2,583. Moscow—6 cases electrical material, $420. Newcastle—1 case electrical machinery, $200. Oporto—3 cases electrical machinery, $196. Peru—5 packages electrical machinery, $1,532; 16 packages electrical material, $393. Southampton—37 packages electrical material, $3,322; 1 case motor vehicle parts, $117. Santo Domingo—12 packages electrical material, $160. United States of Colombia—29 packages electrical material, $235.

EQUIPMENT FOR KANSAS CITY.—The Metropolitan Street Railway Company, of Kansas City, and the Kansas City Electric Light Company will each build a new power house within 18 months. These two power houses will make a complete change in the system for power for trolley lines and for lighting. The power house of the lighting company is to cost $1,150,000. The building alone is to cost $220,000. The company has already contracted for $450,000 worth of electrical machinery for this plant, but has not yet bought its engines and boilers. Besides the central station, there are to be four sub-staions. At each sub-station will be a reducing transformer for lighting. By this plan about 200 miles of electric light wires now in the two Kansas cities will be dispensed with. The power for all the trolley lines of the Metropolitan Street Railway will be generated in two central power houses. One of these is to be in Kansas City, Mo., and the other in the Riverview station, across the Kaw River in Kansas City, Kans. The capacity of the Riverview power house is 14,000 horse-power. That of the new station will be 30,000 horse-power, and it will cost $1,000,000. A part of the electrical equipment for this house has been contracted, but not all of it.

THE STURTEVANT FIRE.—The fire which visited the works of the B. F. Sturtevant Company at Jamaica Plain, Mass., on Sunday, April 14, proved to be far less disastrous than was first reported. Only the engine and electrical departments were injured. The power plant was started up with but a single day's delay incident to renewing belts damaged by fire, and the entire blower, heater, forge, galvanized iron and shipping departments, with the foundry, pattern shop, etc., were in full operation on that day, and the shipments going forward as usual. No valuable office records were lost, the most serious damage occurring in the advertising department, where a large amount of printed matter was destroyed. Fortunately, however, an entirely new catalogue was in press, and copies were issued on the 16th in time to meet all demands for information. New offices were established on Monday morning in a nearby building, and by Monday noon the business was running as usual. With these facilities at its disposal there is no likelihood of any delay in shipments, except such as may occur in the electrical and engine departments, and arrangements are already made for handling this work.

STEEL CAR PLANT.—The new plant of the American Car & Foundry Company in Detroit, Mich., is complete in its equipment, and represents an investment of nearly three-quarters of a million of dollars. The main buildings, which are over 800 ft. long and 200 ft. wide, are equipped with electric, pneumatic and hydraulic machinery. Three kinds of power will be distributed by means of pipes and wires throughout the shops. One of the features of the plant is a large traveling crane above the network of railroad tracks in the yards. This crane will pick up cars in all stages of completion and transfer them from track to track, as desired. There will also be several cranes and transfer tables in the shops. The entire plant is built after the plans of the Westinghouse, Church, Kerr & Co., and will be equipped throughout with electric motors, hydraulic and pneumatic apparatus, and will be lighted by arc and incandescent lights.

LUNDELL MOTORS FOR GOVERNMENT.—In Government work Lundell motors and generators, manufactured by the Sprague Electric Company, are used to a large extent. Recent orders include 17 motors of various sizes for the Norfolk Navy Yard, three 35-hp motors for the Mare Island Navy Yard, four furnished by George A. Ohl & Co., and five motors, one generator and a 2-kw ventilating set for the Brooklyn Navy Yard. In addition to the Government orders, the Sprague Electric Company reports the following among its larger sales: Steelton Light & Power Company, one 125-kw belted type generator; Columbia University, three 75-kw engine type generators; C. S. Ashley, one 125-kw generator; Pittsburg Reduction Company, one 25-hp motor and one 166-hp motor; National Meter Company, one 37½-kw engine type generator; Chase Rolling Mill Company, one 125-kw belted type generator, and the Evansville Gas & Electric Company, one 150-kw generator.

THE ELECTRICAL FIRE RISK.—President James, of the Northwestern National Insurance Company, Chicago, charges the increased losses by fire to the use of electricity. He says: "The present uses of electricity have increased fire losses in the United States in the last five years 25 per cent, and the companies doing business in this country will be compelled to advance rates to meet this hazard or retire from the field." President James said he expected the present year to be the culminating one in losses. He believes something will have to be done by companies remaining in the business, as the candle is burning at both ends—low rates and heavy losses.

CAHALL BOILERS.—The Altman & Taylor Machinery Company, Mansfield, Ohio, through its sales agency, reports the demand for Cahall boilers as steadily increasing. Among the recent orders are the following: Four boilers, aggregating 1000 horse-power, for the Grand Rapids, Holland & Michigan Railway Company, Grand Rapids, Mich.; four boilers, aggregating 1300 horse-power, for the Des Moines City Railway Company, Des Moines, Iowa; three 500-hp boilers for the E. P. Allis Company, Milwaukee, Wis., and three boilers, aggregating 1000 horse-power, for the American Steel & Wire Company, Chicago, Ill.

THE MORRIS ELECTRIC COMPANY, of 15 Cortlandt Street, New York City, is in the market for the following items needed for export purposes: Tell-tale arrangement for a switchboard to attach to 16-feeder panel circuit-breakers and three generator panels; steam-driven automatic air compressors, with tanks, and so forth; motor-driven automatic compressors to be used for blowing the dust out of generators, motors, cars, etc.; 2000 brake shoes and woodworking machinery suitable for car shops.

NINE-HOUR WORKDAY.—The Electrical Machinists and Instrument Makers' Union, which is a branch of the International Association of Machinists, held a meeting last week in this city and decided to join the nine-hour demand of the machinists, which goes into effect on May 20. Both the union and non-union men will make the demand.

MR. L. T. LEVY, who has been the sales agent for the Falcon Electric Manufacturing Company, will open an office at No. 234 Greenwich Street, and will act as the sales agent for both the Falcon Electric Manufacturing Company and several other firms. Mr. Levy has formed a co-partnership with Mr. L. E. Frorup at the above address.

EUROPEAN WANTS.—Our advertising pages present the interesting feature this week of two well-known European concerns advertising for American electrical engineering talent to be employed in their shops, and one prominent manufacturer of telegraphic, telephonic apparatus, etc., asking for agencies for such American goods for Germany and Russia.

THE RICHMONDT ELECTRIC WIRE CONDUIT COMPANY, not incorporated, of Milwaukee, Wis., is removing its business to Waukegan, Ill., where it will occupy a part of the plant of the Thomas Brass & Iron Company. It is now transferring its machinery, etc.

ELECTRICITY FOR RAILWAY TUNNEL.—It is reported that the Great Northern Railway Company will substitute electric power for the present steam locomotives in hauling trains through the tunnel at Cascade. The eastern end of the tunnel is 235 ft. higher than the western end.

RAILS FOR GLASGOW.—Rails for the extension of the electric lines of Glasgow are to be furnished by American manufacturers, according to cable advices received here. About 3,450 tons of rails will be required, at a cost of $110,000. Nearly all of the original equipment of the Glasgow lines also came from the United States.

THE MONTAUK MULTIPHASE CABLE COMPANY, of New York City, has secured an order for the installation of its automatic fire-alarm service in the American Museum of Natural History, Seventy-seventh Street and Columbus Avenue. The system is eminently adapted for this important class of service.

THE AMERICAN BRIDGE COMPANY will furnish to J. G. White & Co., Inc., New York, the structural steel work for the power plant for the Kalgoorlie Electric Power Company, Kalgoorlie, Australia. This plant consists of an engine house 43 ft. by 159 ft., with a lean-to 17 ft. by 40 ft., and a boiler house 41 ft. by 132 ft.

General News.

THE TELEPHONE.

BIRMINGHAM, ALA.—The linemen of the People's Home Telephone Company, of Birmingham, have returned to work, all differences growing out of the working of white and colored labor together having been adjusted. The races will now be worked in separate squads.

SAN FRANCISCO, CALIF.—The Lake County Telephone & Telegraph Company has been organized in Paisley, Oregon.

SAN FRANCISCO, CALIF.—In Oregon and Washington there is a good deal of activity among the independent telephone companies, although the Pacific States Company has a comprehensive long-distance system, extending from Los Angeles, Calif., to Spokane, Wash., and has promised to install an exchange in every town on the Coast.

SAN FRANCISCO, CALIF.—The San Francisco exchange of the Pacific States Telephone & Telegraph Company's system, reported an increase of 1,500 telephones during the month of March, making the total number in that city over 24,000 telephones. The population of the city is placed at 342,000 and the number of telephones in use is said to be only 1,000 less than Chicago has. Los Angeles has 9,000 telephones, with a population of 102,000.

PECK, IDAHO.—The Nez Perce Farmers' Co-operative Telephone Company has completed its barbed wire line to Nez Perce. The line is over thirty miles in length, and has twelve telephones on it.

INDIANAPOLIS, IND.—The Elizaville Co-operative Telephone Company, of Elizaville, and the Farmers' Co-operative Telephone Company, of Clarkshill, have been incorporated.

INDIANAPOLIS, IND.—During the past week articles of incorporation were filed with the Secretary of State for the Carmel Telephone Company, Carmel; the Markleville Telephone Company, Markleville and the Farmers Telephone Company, Madison county.

TERRE HAUTE, IND.—The New Citizens' Telephone Company opened up for business on April 8, with 250 telephones and has added about 15 instruments daily ever since. Seventeen girls are employed on the switchboard and the plant is giving excellent service.

FRANKFORT, IND.—Judge Kent has authorized Richard C. Clark, receiver for the Energy Telephone Company, of this city, to borrow $5,000 with which to complete the plant, make repairs, pay off the laborers and otherwise place the plant in its full earning capacity. A local company has been organized to purchase the plant.

SPRINGFIELD, ILL.—The Lawrence County Telephone Company, Lawrenceville, has been incorporated; capital stock, $3,500. Incorporators, S. J. Gee, A. N. Fink and A. M. Maxwell.

BALTIMORE, MD.—The Maryland & Delaware Telephone Company, which owns the line from Queenstown, Md., to Rehoboth, Del., has been granted a franchise for the construction of a line in Cecil county to connect the various communities.

WORCESTER, MASS.—The Worcester Telephone Exchange is making extensive improvements in its service, and is installing the central energy system.

MINNEAPOLIS, MINN.—The Enterprise Telephone Company, of Edgerton, Pipestone County, has filed articles of incorporation, and fixes its capital stock at $50,000. The directors are Edward Yocum, William Lockwood, C. G. Brady, C. S. Howard and E. W. Davies.

MINNEAPOLIS, MINN.—The Twin City Telephone Company has contracted for 150,000 feet of telephone cable varying from twenty-five pairs of wires to a cable of 200 pairs. An entire season's supply has been ordered from the John A. Roebling's Sons Company, of New York.

WINTHROP, MINN.—The People's Independent Telephone Company, whose organization was recently noted in these columns, expects to begin business about May 10. It will use apparatus of the Stromberg-Carlson Company, the board having a capacity of 200 lines. The company has 65 subscribers. It expects to build farmers' lines in the Fall. Its rates are $1.50 per month for business telephones and $1 for residences.

MEXICO, MO.—A new telephone line is to be built south from Farber, Audrain county.

VERSAILLES, MO.—The Versailles Telephone Company has been incorporated with a capital stock of $5,000. The incorporators are Louis Straus, J. W. Mills, A. Hopper, and others.

ST. JOSEPH, MO.—A meeting of representative farmers of Kansas, Northern Missouri, Southern Iowa and Nebraska was held here a few days ago, and arrangements made for extensions in telephone service to farmers in the territory named.

BUFFALO, N. Y.—The Bell Telephone Company has installed a new exchange in North Tonawanda at an expense of $12,000.

FAR ROCKAWAY, L. I.—The New York & New Jersey Telephone Company will open a new and handsome exchange here on May 1. There are over 400 telephone subscribers at Far Rockaway and Rockaway Beach.

PERTH AMBOY, N. J.—The Seaboard Telephone Company, of this city, has been incorporated. Capital, $10,000. Incorporators: Charles K. Seaman, James M. Glenn, Wm. H. McCormick, Wm. B. Bratt, James H. Voris.

LONDON, OHIO.—The London Telephone Company has been incorporated with $75,000 capital stock.

OTTAWA, OHIO.—The Putnam Telephone Company has increased its capital stock from $40,000 to $100,000 to provide for improvements.

BRIDGEPORT, OHIO.—The Belmont Telephone Company has increased its capital stock from $15,000 to $75,000 to provide for improvements.

RAVENNA, OHIO.—The Ravenna Home Telephone Company has 370 subscribers and operates 25 miles of toll line. A number of additions are being made.

LOWELLVILLE, OHIO.—The Youngstown Telephone Company has secured a franchise in this place and is preparing to install an exchange with 100-drop capacity.

DAYTON, OHIO.—The Progress Telephone & Telegraph Company, of West Milton, has secured a franchise to run lines into Dayton, and 100 subscribers have been secured.

CUYAHOGA FALLS, OHIO.—The Central Union Telephone Company is making an effort to keep the Akron People's Telephone Company out of this field by reducing rates.

DELAWARE, OHIO.—The Citizen's Telephone Company is erecting new cables and installing an additional switchboard. The company has 553 subscribers connected up at the present time.

SANDUSKY, OHIO.—The Sandusky Telephone Company has recently installed an additional section of North Electric Company central energy switchboard giving a capacity of 2400 drops. This company has over 900 subscribers and operates about 45 miles of toll lines.

TROY, OHIO.—The Troy Telephone Company is installing an additional section to its switchboard; contract having been placed with the American Electric Telephone Company. The Troy Company is eighteen months old and has 423 subscribers connected up, with 30 on a waiting list.

KENT, OHIO.—The Kent Home Telephone Company has ordered an additional section of switchboard to accommodate 400 drops. Fifty miles of toll line are being built and 14 toll stations are being installed in surrounding towns. North Electric Company's apparatus is to be used throughout.

SPRINGFIELD, OHIO.—The Central Union Telephone Company is making every effort to thoroughly cover this field before the proposed independent company secures a franchise. A sub-exchange with 200 drops is to be installed at New Carlisle and toll lines are to be built to Vienna, Brighton, Harmony, Plattsburg, Husted, Dialton and Pinchen.

WAPAKONETA, OHIO.—The Wapakoneta Telephone Company is installing a Stromberg-Carlson switchboard of 500 drops capacity and has 130 subscribers connected. The promoters of this company are also building the following exchanges: New Carlisle, 200 drops; Cridersville, 100 drops; Waynesville, 100 drops, and Lake View, 100 drops. Franchises have been secured in all of these towns and contracts will be placed for apparatus in the near future.

CINCINNATI, OHIO.—The ninety male employees of the City & Suburban Telegraph Association of this city held their first annual banquet Saturday evening, April 13. Handsome decorations of bunting, electric lamps of various colors, flowers and evergreens added much to the attractions. Everything was done by the employees themselves. The program was unique and carried out the suggestion of a large minstrel entertainment. Speeches were made by officials.

MONROEVILLE, OHIO.—The Huron County Telephone Company, which has been bought up by Frank A. Knapp and C. R. Calaghan, of Bellevue, consists of 50 miles of toll lines with about 100 telephones, including small exchanges at Monroeville, Plymouth, New Washington and Chicago Junction. They are preparing to build about 12 additional miles of toll line, and will have long-distance connection through the lines of the United States Telephone Company.

ASHLAND, OHIO.—The Star Telephone Company is preparing to rebuild its system in this place and has placed contracts with the Kellogg Switchboard & Supply Company, of Chicago, for 400 new telephones and a 600-drop switchboard on the central energy system. A number of new toll lines will be built and long distance connection will be made over the lines of the United States Telephone Company. The capital stock of the company has been increased from $50,000 to $100,000.

PORTLAND, ORE.—The Columbia Telephone Company in this city is carrying on a large and profitable business in competition with the Bell system, but in order to compete more successfully it will need to establish long-distance lines paralleling those of its rival. The company is now looking for $250,000 to use in improving its system and extending a few outside lines already constructed. The company's present plant cost $200,000. The company is free from debt.

COOKEVILLE, TENN.—The capital stock of the Overton Telephone Company has been increased from $5,000 to $25,000, and the company has been completely reorganized.

MEMPHIS, TENN.—The telephone war between the Bell Company and the Independent Telephone Company, organized recently in this city, is now on, and the indications are that lively times are ahead which will result in giving the city a telephone service at a more reasonable cost than heretofore.

CLARENDON, TEX.—The Clarendon Telephone Company has been incorporated with a capital stock of $30,000. The incorporators are R. W. Tally, John M. Clower, J. D. Stocking and A. M. Beville.

MABANK, TEX.—The Boyett & Smith telephone lines have been purchased by the Kemp & Kaufman Telephone Company, of Kemp. By this deal the purchasers will now control over a hundred miles of wire, extending from Kaufman to Athens and from Corsicana to Tyler, with branch lines from Mabank to Prairieville, Roddy and Paynes Springs. The new owners purpose making extensive improvements in the service and will extend the line recently built to a point twenty miles south of Athens on the Texas & New Orleans Railroad on south to Jacksonville as rapidly as that road is constructed.

MILWAUKEE, WIS.—The Wisconsin Telephone Company reports a net gain of 179 subscribers in March, making a total of 21,122 subscribers on March 31.

MILWAUKEE, WIS.—A measure has been introduced in the common council to compel the Wisconsin Telephone Company to put all its cables underground. The company has all its wires underground even beyond the limit mark, and opposes this new measure.

ELECTRIC LIGHT AND POWER.

MONTGOMERY, ALA.—Mr. Emerson McMillin, of New York, has engineered a scheme which has succeeded in bringing the Montgomery Light & Power Company into the big consolidation of gas and lighting plants in the United States. Mr. McMillin invested $600,000 in a plant near Tallahassee, Ala., and wires have been run to Montgomery by which lights can be furnished to Montgomery consumers. The consolidated company has a capital of about $1,300,000.

SAN FRANCISCO, CALIF.—The Mossbrae Falls Water & Power Company, of Dunsmuir, Calif., has been incorporated. Directors: L. Van Fossen, F. B. Van Fossen, J. Beaton, E. J. Bowen and F. H. Simmons. Capital stock, $25,000; subscribed, $5,000.

SAN FRANCISCO, CALIF.—The Red Bluff Light & Power Company was recently incorporated, with San Francisco as the principal place of business. Directors: W. I. Priest, E. J. Johnson, J. E. Ennis, C. E. Trekell and G. A. Petterson. Capital stock, $75,000; subscribed $500.

MARION, IND.—Marion C. Mead & Company, a corporation operating one of the electric light plants of this city, will in the near future extend its service to South Marion.

BALTIMORE, MD.—The directors of the United Electric Light & Power Company have declared the regular dividend of 2½ per cent. on the preferred stock. Earnings of the Company have greatly increased, and there is a surplus after this payment.

BALTIMORE, MD.—The Reisterstown & Glyndon Water, Light & Power Company, of Baltimore county, Md., has been incorporated. The incorporators are Reister Russell, T. Rowe Price, William L. Shriver, Daniel H. Bollinger, Frank H. Zouck, James Gore and George W. Albaugh. The capital stock is $25,000.

AUGUSTA, ME.—The Boothbay Harbor Light, Heat & Power Company has been organized at Boothbay Harbor for the purpose of generating and supplying gas or electricity, with $10,000 capital stock. The officers are: President, K. H. Richard, of Boothbay Harbor; treasurer, C. J. Marr, of Boothbay Harbor. Certificate approved April 3, 1901.

MACKINAC, MICH.—The Municipal Water, Light & Power Company, Mackinac Island, has been incorporated; capital, $100,000.

ST. LOUIS, MO.—The construction of the new municipal electric light and power plant at Baden will be commenced about May 1. This plant when furnished will light the pumping stations, water works and water towers.

MEXICO, MO.—The question of the municipal ownership of the electric light plant and the waterworks system will probably be submitted to a vote of the people of the city this spring.

CHARLOTTE, N. C.—The scheme for developing Mott's Falls, thirty miles from Charlotte, involving, it is said, about $800,000, has matured to the point of asking a franchise from the city of Charlotte. Mr. F. I. Van de Venter and others are interested.

RALEIGH, N. C.—The Raleigh Ice & Electric Company, which is harnessing the water power at Milburnie, near Raleigh, will be ready to furnish power and light to Raleigh within two months. The entire plant will represent an outlay of about $50,000.

BELVIDERE, N. J.—A syndicate is acquiring all the extensive water rights at the mouth of the Paulins Kill, in Warren county, and the Washington Mills have just been bought. Engineers are already at work laying out plans for a big electric light plant. The object of the syndicate is to furnish power for electric lighting to Columbia, Portland, Water Gap, Hainsbury, and Delaware, and also for trolley lines from Portland to Bangor and up through the Delaware Water Gap and the Paulins Kill Valley.

ROCHESTER, N. Y.—The stockholders of the Citizens' Light & Power Company have called a meeting for May 2 for the purpose of increasing the capital stock of the company from $150,000 to $2,500,000. The increase in capital is for the purpose of assisting in the construction of the new power house, which is estimated to cost $2,000,000, and remodelling the present power station.

ALBANY, N. Y.—The Assembly has reported favorably the bill of Assemblyman Leggett incorporating the Lower River Power & Water Supply Company of Niagara, with a capital of $5,000,000, amended so as to continue its operations to Niagara county. The incorporators are Commodore P. Veeder, Tunis G. Bergen, William Williams, Charles E. Hotchkiss and Dewitt V. D. Reily, of New York, and Patrick F. King, George W. Knox and James S. Simmons, of Niagara Falls, N. Y. The company is to take its water out of the Niagara River below the falls so as to avoid the criticism of spoiling the natural beauty of Niagara.

HUBBARD, OHIO.—The Hubbard municipal lighting plant was destroyed by fire a few days ago. The loss was about $10,000; insurance $3,000.

CINCINNATI, OHIO.—The Cincinnati Edison Electric Company is connecting up its underground system with the storage batteries in its new building on Government Square.

WAPAKONETA, OHIO.—The annual report of the trustees of the municipal water works and lighting plant shows that the plant has been a good investment. The plants earned $6,642 over and above interest charges, or 7.2 on the investment.

TOLEDO, OHIO.—The Toledo Lighting & Heating Company has increased its capital stock from $125,000 to $600,000. Contracts have been closed to furnish light and power to a number of manufacturing plants. The plant will cost $250,000.

CINCINNATI, OHIO.—Thos. N. Fordyce, who is to equip the Miami & Erie Canal with boats propelled by electricity, has presented his bond of $25,000, and will commence immediately the construction of fifty boats. The power plant will be built at Hamilton.

CLEVELAND, OHIO.—The Cleveland Electric Illuminating Company is making plans for another addition to its power house. Contracts have been placed for a 2300-hp General Electric generator and for a McIntosh-Seymour vertical engine. The additional building will be large enough for a further installation.

CINCINNATI, OHIO.—A strike is threatened among the electrical workers unless a new schedule is signed by the employers before May 1. The new scale demands a wage rate of $2.00 to $2.50 for outside workers and a ten-hour work day, and $2.50 per day with an eight-hour day for inside wirers. The employers are forming a protective organization, and a meeting has been called for June.

WAPAKONETA, OHIO.—A statement prepared by the officials of the municipal light plant of this city claims the experiment to have been an unqualified success. The waterworks and electric light plants of the town cost $92,000. The annual report of the trustees shows that they have netted the taxpayers, over and above interest, the sum of $6,642, or an equivalent of 7.2 per cent. The street arc lights cost the city $36.32 each.

THE DALLES, ORE.—Articles of incorporation of the Interstate Power Company have been filed in the office of the County Clerk. The object of the concern is to construct and operate an electric light plant at the mouth of the Deschutes River, for the purpose of generating and conducting electric power to points in Wasco, Sherman and Klickitat counties; to institute an electric light system in The Dalles and other points. The Dalles will be the principal office of the company. E. Kurtz, W. H. Moody, H. L. Kuck, L. E. Crowe, Max A. Vogt, J. P. McInerny and E. M. Williams are the incorporators.

NORTH AUGUSTA, S. C.—The North Augusta Electric & Improvement Company, capital $1,500,000, has been commissioned. The company has electrical rights and privileges. Alfred S. Elliott, of Wilmington, Del.; J. M. Jackson, Augusta, Ga., and Henry Brust, of Charleston, S. C., are the corporators.

MANCHESTER, VT.—An electric light plant will be installed at Manchester by John Marsden, of Utica.

CHATHAM, VA.—The Southern Milling Company, of Chatham, has been chartered, capital $25,000, with right to supply the town of Chatham with lights. J. H. Hargrave, of Chatham, is president of the company.

DAVENPORT, WASH.—The Big Bend Light & Power Company will expend $200,000 in Lincoln county during this year for the purpose of generating electric power at the falls in the Spokane River. The Davenport Council has granted the company a franchise for transmitting power through the town to the Big Bend flouring mill.

BARABOO, WIS.—Papers were filed April 12, transferring the Munger mill property and dam, with franchises, at Kilbourne, to William Guenther and A. D. Johnson, of Appleton, for $40,000. It is understood that a company is to be formed for transmission of electric power to Portage, Baraboo and Madison.

THE ELECTRIC RAILWAY.

NEW HAVEN, CONN.—It is stated that the New York, New Haven & Hartford Railroad Company will equip its Waterbury Division with electric motive power, at a cost of $300,000.

CHICAGO, ILL.—An electric railway between Elgin, Aurora, Geneva, Batavia, and other towns of the Fox River Valley and Chicago is contemplated. The Aurora, Wheaton & Chicago Electric Railroad Company, it is said, has just completed negotiations for the sale of $3,000,000 bonds to a syndicate of bankers of Cleveland. The new road will have about thirty-five miles of main line to connect with the consolidated combination, and branch lines wherever necessary. The companies that are to consolidate are the Batavia & Eastern Railroad Company, capital $100,000; Elgin City, Carpenter & Aurora Railroad Company, capital $500,000, bonds $300,000; Aurora & Geneva Railroad Company, capital $150,000; Aurora Street Railroad Company, capital $300,000, bonds $300,000, and the Geneva, Batavia & Southern, with a capital of $100,000. The present capital of the Aurora, Wheaton & Chicago Electric Railroad Company is $1,500,000, but as the plan of operation has been enlarged the capital will be increased. B. Mahler is the President of the company and L. J. Wolf is the vice-president.

TOPEKA, KAN.—The Iola Electric Street Railway Company has been incorporated with a capital of $50,000. The officers are: President, F. V. Crouch, of Carrollton, Mo.; Vice-President, L. L. Northup, of Iola; Treasurer, George Bowlus, of Iola. The company will build a line in Iola this summer.

NEWPORT, KY.—Officers of the South Covington & Cincinnati Street Railway Company have been elected as follows: President, James C. Ernst; Superintendent, James R. Ledyard; Chief Engineer, E. Darrow; Purchasing Agent, R. W. Phillips. The same gentlemen are also officers in the Union Light, Heat & Power Company, with the exception of the Superintendent, Mr. Ward Barnum filling that position in the latter named company.

THIBODEAUX, LA.—There is an excellent opportunity here for an electric railway. For further information on this subject Mr. L. H. Lancaster may be addressed.

BALTIMORE, MD.—It is understood that the United Railways & Electric Company is considering a proposition to purchase its holdings of United Electric Light & Power Company stock, which it controls. The final aim of those who desire to purchase the electric lighting stock is believed to be to unite both the gas and electric plants here, forming an illuminating monopoly in Baltimore.

JACKSON, MICH.—W. A. Boland, president of the Detroit & Chicago Traction Company, has closed a contract with the General Electric Company for $211,000 worth of electrical material for the road. It includes the machinery for the $250,000 power plant at Jackson and for the six substations to be built at Dexter, Chelsea, Grass Lake, Parma, Albion and Marshall; also the motors for the fifteen cars now being built for the line.

LYONS, N. Y.—An electric railway is to be built through the village of Palmyra.

LYONS, N. Y.—The Newark Electric Railway Company has been incorporated, with a capital of $50,000. The incorporators have franchises for electric railroads in Clyde, Palmyra and Lyons and are securing franchises in all villages between the cities named.

ALBANY, N. Y.—The Genesee & Orleans Railway Company has been incorporated. The company has a capital of $350,000, and the directors are George W. Aldridge, John H. Gregory, Houston Barnard, George Wilder, Frederick P. Allen, Charles H. Babcock and John F. Kinney, of Rochester; Charles E. Hart, of Albion, and James M. Aikenhead, of Barre, Orleans County.

CINCINNATI, OHIO.—The Cincinnati Traction Company and a company organized by Tilden R. French, C. A. Bosworth atnd L. C. Black are fighting over a franchise through Norwood.

CINCINNATI, OHIO.—The Southern Ohio Traction Company has been sued by the State of Ohio because of refusal to place safety devices at its crossings over the C., H. & D. tracks at Trenton.

WARREN, OHIO.—The Cleveland & Chagrin Falls Electric Railway Company has closed contracts for private right of way from Garrettsville to Warren and will have the new line in operation Sept. 1.

COLUMBUS, OHIO.—The Columbus, Grove City & Southwestern Railway Company, whose incorporation was recently noted in these columns, will build an extension of ten miles to Mt. Sterling. The company is renting its power at the present time.

SCRANTON, PA.—The Scranton & Wilkesbarre Rapid Transit Company has awarded a contract of $1,155,000 to the Westinghouse Electric & Manufacturing Company for the electrical equipment of the road.

THE AUTOMOBILE.

AUTOMOBILE FREIGHT LINE.—A despatch from Los Angeles, Calif., states that the Great Northern Railway Company intends to inaugurate a line of automobiles to carry oranges from the principal packing houses to the seaports.

PHILADELPHIA, PA.—Mr. W. H. Johnson, of the Philadelphia Electric Company, reports that that concern has bought a runabout from the Pennsylvania Electric Vehicle Company, to be used by its superintendent as an experiment in time saving in getting around the district and looking after the various gangs at work. This is an excellent field for the employment of automobiles.

LONG ISLAND TEST RUN.—Blue ribbons for first prize have been awarded to Fred. Walsh and H. S. Chapin in the 100 miles endurance test of automobiles on Long Island roads on Saturday last. Meyers and Uppercue were first in, but were disqualified for excessive speed, having finished the run in a little over five hours. Red Ribbons were awarded to H. B. Barruck, E. F. Grueter, and C. J. Field, and F. A. Law and A. L. McMurtry got yellow ribbons for making stops of not more than thirty minutes. Three silver trophies were awarded in the hill-climbing contest, the first going to F. A. Law, the second to E. F. Grueter, and the third to C. J. Field. The latter trophies were for various weights of machines. The weather was frightfully bad.

LEGAL.

TELEGRAPH RATES.—The Supreme Court of the United States on April 15 affirmed the judgment of the Superior Court of Nebraska against the Western Union Telegraph Company, and in favor of the Call Publishing Company, of Lincoln, Neb., that the rates on news matter to that paper were unjust and unreasonable as compared with the same service to the Nebraska State Journal, published in the same city. Justice Brewer, in announcing the decision of the court, said that the principles of common law are operative upon all interstate commercial transactions except as modified by Congressional enactment.

SWITCH SIGNALS. The United States Circuit Court, in the Pittsburg District, has made an order in the case of the Hall Signal Company against the Union Switch & Signal Company, vacating the order suspending the injunction against the defendants. The suit, which involved the rights to an improvement in circuit controlling devices, was filed on April 19, 1893, and on October 24, 1900, was decided to the effect that the defendant company had infringed the patent. A permanent injunction against them was granted, an appeal was taken and an order was made suspending the injunction upon the filing of a bond of $5000 to cover the damages. The order now made suspends this latter order, and the injunction is now in full force.

OBITUARY.

MR. E. R. BARTLETT.—We regret to record the sudden death, caused by the running away of the horse he was driving, of Mr. E. R. Bartlett, formerly of the Maintenance Company of New York City, and a member of the New York Electrical Society. Ernest Russell Bartlett was born in Brooklyn in 1870, and after receiving an ordinary public school education was interested as a contractor in the building of the first trolley lines in Brooklyn. He followed electrical railway contracting up to the time of assuming control of the exhibit of the Ansonia Electric Company at Chicago, which he represented at the Fair. At the close of that exhibition he came East in 1895, when he became interested in the Maintenance Company, and was its first treasurer, holding that position up to last October, when he resigned owing to ill-health. Since then he had been at various places trying to recuperate, and had just returned from Old Point Comfort, Virginia, two days before the accident which caused his death. He was well and favorably known in the electrical circles throughout this city and Chicago.

MR. H. H. LUSCOMB.—We regret to announce the death of Mr. Henry Herbert Luscomb, the secretary and superintendent of The Johns-Pratt Company, of Hartford, Conn. Mr. Luscomb, who was one of the pioneers of the development of street railway insulators and moulded insulation, died after an unusually severe attack of pneumonia, to which he succumbed after an illness of but six days. At thirty-five years of age Mr. Luscomb had attained a prominent position in the electrical manufacturing world, having succeeded in obtaining the important position he occupied at the time of his death by dint of hard personal effort and sterling worth and ability. He became connected with The Johns-Pratt Company in 1892, when the street railway insulation business was in its infancy. At this time The Johns-Pratt Company absorbed the Gould & Watson Company, an employee of which latter concern Mr. Luscomb was at the time. Joining The Johns-Pratt Company, as foreman of one of its departments, he rapidly rose to the position of superintendent in 1895 and was elected secretary of the company in 1898. His force of will and grit were notable elements in his character and his ingenuity as an inventor manifested itself in a great number of highly ingenious appliances used at the present time in street railway line work and other fields of applied electricity. Mr. Luscomb's death is a loss to the company, which the officers and employees severely feel, as he possessed mechanical and commercial genius to a marked degree. He leaves a widow and two children and a host of sorrowing friends.

MR. R. P. ROTHWELL.—Richard Pennefather Rothwell, editor and general manager of the *Engineering and Mining Journal* and a mining engineer of international repute, died on April 17 in New York City. He was born at Ingersoll, Ont., in 1837. He was graduated from the Rensselaer Polytechnic Institute at Troy in 1858, and studied at the Imperial School of Mines at Paris and the Mining Academy at Freiberg, Saxony. In the field of manufacturing mining and in the treatment of ores Mr. Rothwell made many notable inventions. A contour map he made in 1869 of the anthracite strata of the Panther Creek Valley for the Lehigh Coal & Navigation Company is still in use, its accuracy and completeness being such that scarcely any modifications have been made in its details. Complete surveys and contour maps of the Wyoming Valley and Cahaba coal fields, which Mr. Rothwell subsequently made, have since been adopted by the Pennsylvania and United States geological surveys. He removed his headquarters to this city in 1873 and shortly afterwards acquired an interest in the *Engineering and Mining Journal*. In 1892 Mr. Rothwell began the publication of "The Mineral Industry, Its Statistics, Technology and Trade," a cyclopedia of mining, metallurgy and industrial chemistry, which is issued yearly in one volume. Mr. Rothwell was a member of many clubs and societies. He had charge of the gold and silver statistics for the United States Census in 1890. The funeral services in his memory were held at his late residence in this city on April 20. A large number of mining engineers, metallurgists, and friends of the deceased editor were present and the Rev. Mr. Patey officiated.

PERSONAL.

PROF. G. D. SHEPARDSON has an interesting article in the May *Forum* on train lighting.

MR. G. H. DAY, president of the Electric Vehicle Company, is spending down South a well-earned holiday.

MR. JOHN W. MACKAY, president of the Postal Telegraph-Cable Company, recently arrived in San Francisco, and will spend several weeks in looking after his Western interests.

MR. ALEX. HENDERSON, of the Sprague Electric Company, reports from the West, namely, the hotel of that name at Minneapolis, Minn. He will not be back in New York for a week or two.

MR. C. O. MAILLOUX, consulting electrical engineer, has removed his offices from the American Tract Society Building to the Bishop Building, 76 William Street, corner of Liberty Street.

GEORGE PEGRAM, chief engineer of the Manhattan Elevated Railway Company, while inspecting the elevated road structure at 178th Street and Third Avenue last week had his right arm broken by a piece of iron which fell on it.

MR. GEORGE C. BARTRAM, formerly in the contracting department of the Boston Bridge Works, has recently connected himself with the Clark Automatic Telephone Switchboard Company, Providence, R. I., in a similar capacity.

MESSRS. W. N. JACKSON and J. H. Clark, presidents respectively of the Central Union Telephone Company and Chicago Telephone Company, will both retire from those offices, it is said, in order that they may be concentrated in Mr. John I. Sabin, as noted elsewhere in this issue.

MR. PETER COOPER HEWITT, whose work in electric lighting has recently attracted so much attention, has gone abroad for a little rest and recreation. The past winter has been spent in very strenuous investigation and experiment.

MR. MAX LOEWENTHAL, electrical engineer, of this city, has sustained a severe loss in the death of his father, aged only 57, from a stroke of apoplexy. The deceased, Mr. W. Loewenthal, was of amiable character, and is painfully missed by his circle of relatives and friends.

MR. J. S. FORBES.—It is stated that Mr. J. S. Forbes will shortly resign the chairmanship of the Metropolitan District Underground Railway of London, and will be succeeded by Robert William Perks, M. P. for Lincolnshire. The railway referred to is the old London underground, now to be electrified.

MR. F. P. FISH, who has so long been counsel for the Bell Telephone and General Electric interests, has been elected president of the American Telephone & Telegraph Company and of the American Bell Telephone Company, now virtually one thing. He takes the place of acting president Cochrane, and his election goes into effect, it is said, as of July 1, 1901.

MR. U. G. ROGERS, general manager of the recently organized Rogers Electrical Works, brings to his company an enviable experience in the manufacture of telegraph and other instrumental apparatus. He was formerly superintendent of the factory of J. H. Bunnell & Company, and has made a close specialty of the refined mechanism in the branch of the art with which the new company will deal.

MR. F. W. TOUSEY.—We record with deep regret the recent death of Mr. Frederick W. Tousey. assistant secretary of the Automobile Club of America, after an attack of typhoid pneumonia. He was well known on both sides of the Atlantic for his active, excellent services in promoting the cause of automobil-

ism, and it had been intended to leave much of the work on the New York-Buffalo endurance test in his hands.

DR. E. A. ENGLER.—The trustees of the Worcester Polytechnic Institute have unanimously elected Dr. Edmund A. Engler, of St. Louis, to be the successor of Dr. Thomas C. Mendenhall, as President of that institution. Dr. Mendenhall retires on account of ill-health. His resignation takes effect at the end of the present school year, and Dr. Engler is expected in Worcester in a few weeks to take up his new work. Prof. Engler was born in St. Louis in 1856, and was graduated from the Washington University there in 1876. He received the degree of A. M. in 1879 and of Ph.D. in 1892. He has been professor of mathematics in the university since 1881. Since 1896 he has been Dean of the Engineering School of the University. His specialty is higher mathematics.

MR. R. A. C. SMITH was presented last week with a gold loving cup at a dinner which was given to him at Delmonico's by a number of his friends who had recently been his guests on a trip to Cuba and the West Indies. Havana, Santiago de Cuba, and Port Antonio were among the places visited, and scenes from these cities are represented on the panels of the cup, which was made by the Tiffany Company. The base of the cup represents dolphins' heads, out of which rise cocoanut palms, the leaves of which form the cup. Mr. Smith was not the only one who was surprised by a gift. He himself had provided a pleasant souvenir of the occasion in the shape of albums containing photographic half-tones of scenes along the trip, the originals of which had been taken by Mr. Smith himself. Besides there was a complete chart of the course of the voyage as sailed, with extracts from the log.

Trade Notes.

THE CINCINNATI PLANER COMPANY will have an exhibit at the Pan-American Exposition in Section 36 of Machinery Hall.

REMOVAL.—Messrs. Sargent & Lundy, mechanical and electrical engineers, Chicago, will on May 1 occupy new quarters in the Isabella Building, 46 East Van Buren Street, Chicago.

THE WESTERN ELECTRIC COMPANY, Chicago, is sending out bulletins on speaking tubes, annunciators and combination letter boxes. This company manufactures a large line of this material, and is able to supply all such needs.

GROUND DETECTORS.—High voltage ground detectors, type D, constitute the subject of Bulletin No. 116, issued by the Stanley Electric Manufacturing Company, Pittsfield, Mass. These devices are illustrated in perspective and diagrammatically.

THE NEW YORK CENTRAL has issued a most valuable and interesting bulletin No. 13, in which Mr. Daniels, General Passenger Agent, shows how the urban population has grown, why it has grown, and where the incalculable benefits of the steam railroad come in.

MR. EDW. P. THOMPSON, the patent attorney, will on May 1 remove his headquarters to No. 156 Fifth Avenue, New York. Mr. Thompson calls attention to the central location of his new office, which will be appreciated by his clients and visitors. The building in which he will be located is near the site of one of the stations of the underground railway.

NEW CONDUIT PLANT.—The plant of the Safety Armorite Conduit Company at Rankin Station, Pa., which was destroyed by fire several months ago, is to be rebuilt. The company has given the contract to the American Bridge Company for a steel frame and iron-clad building, to take the place of the one burned. The new building will be 200x50 feet in dimensions. The plant will be ready about September 1 and will give employment to about 200 hands.

MICA MINING.—Messrs. Eugene Munsell & Company, 213 Water Street, New York, are distributing to the trade a pamphlet containing a collection of reproductions of photographs, which is quite new in this line. The object is to illustrate the methods of mica mining. The illustrations represent scenes in the mica mines of India and show the various stages in the process of mining, to the final shipment of the product to the market for consumption. Some views are also given of Canadian and North Carolina mica mines.

THE WELLMAN-SEAVER ENGINEERING COMPANY, Cleveland, Ohio, is preparing plans for the erection of a large manufacturing plant in Cleveland, in which it proposes to fill all its own contracts instead of letting out the work to other companies, as has been its rule in the past. The company controls a number of valuable patents on special machinery for steel work practice and hereafter will do all its own manufacturing under these patents, besides its own structural work and electric crane manufacturing.

MECHANICAL DRAFT.—A third edition of the instructive booklet, Bulletin J, relating to "Mechanical Draft; What it Is and What it Does," has just been issued by the B. F. Sturtevant Company, Boston, Mass., of whom a copy can be obtained upon application. It illustrates applications under both the forced and induced methods, and shows the Sturtevant blower works as they now appear without a chimney, a fan being employed exclusively for producing the required draft for about 400 boiler horse-power.

BAKER MOTOR VEHICLES.—The Baker Motor Vehicle Company, Cleveland, Ohio, is making regular shipments of vehicles. During the past six months the company has been turning out runabouts in lots of twenty-five and has sent them to all parts of the country. A lot of twenty-five is now going through which will be sent to agents recently appointed. In New York the Baker Company is now represented by Mr. Budd Gray, who makes his headquarters with the Automobile Exchange & Supply Company, West Thirty-eighth Street.

PAN-AMERICAN.—The American Bridge Company will make quite an elaborate building exhibit at the Pan-American Exposition, furnishing two buildings each about 60 feet in width and about 150 feet in length. One of the buildings will be of extremely plain construction, being designed for the use of a manufacturing plant. The second, however, will be of ornamental design, such as would naturally be used for freight depots, street car barns and that class of structures. The American Bridge Company will also make an extensive exhibit of parts of large bridges.

BALL BEARINGS FOR UNIVERSAL APPLICATION is the subject of a neat 36-page pamphlet issued by the Auburn Ball Bearing Company, Auburn, N. Y. These bearings are applicable to a great variety of purposes, such as thrust bearings, light and heavy machinery of all kinds and of every speed; for trucks, carriages, automobiles, etc. The company claims that by the use of its ball journal bearings 75 per cent. of the power wasted in friction can be saved, also 95 per cent. of oil and 100 per cent. of babbitt metal. Various kinds of ball bearings are illustrated.

THE ONONDAGA DYNAMO COMPANY, Syracuse, N. Y., has recently spent a considerable sum in increasing the size of its plant, whose capacity is now fully 50 per cent. greater than formerly. This company claims that its success in the manufacture of dynamos and motors is due largely to the fact that it has never permitted its machines to go out without critical inspection and careful tests by the heads of the house. The company assures its customers that in making additions to its plant and increasing its capacity it has also provided for equal care in ascertaining that only perfect machines leave the shops.

METAL WORKERS' ASSOCIATION.—The third annual convention of the National Metal Trades Asociation was held at Detroit, Mich., on April 9 and 10. The convention transacted a good deal of business of interest to the trades represented by the association. Among those present were N. B. Payne, of the Payne Company, Elmira, N. Y.; Ferd Schwedtmann, of the Wagner Electric Manufacturing Company, St. Louis, Mo.; G. E. Emmons, General Electric Company, Schenectady, N. Y.; Wm. Schwanhauser, of H. R. Worthington, Brooklyn, N. Y.; J. C. Hobart, Triumph Electric Company, Cincinnati, Ohio; W. A. Porter, of the E. W. Bliss Company, Brooklyn Borough, New York; S. F. Bagg, Watertown Engine Works, Watertown, N. Y.; A. B. See, of A. B. See Manufacturing Company, Brooklyn Borough, New York; Edward Reynolds, of the E. P. Allis Company, Milwaukee, Wis.; Lewis Searing, Denver Engineering Works Company, Denver, Col., and R. R. Dennis, of the Otis Elevator Company, New York. Of the above-named Messrs. Payne, Schwanhauser, Schwedtmann and Searing are members of the Administrative Council. Mr. Edwin Reynolds, of the E. P. Allis Company, was elected president of the association.

THE WORLD'S WORK, now beginning its second volume, has won its way rapidly. The May number covers important topics in Russia, Austria, England, Mexico, Cuba, besides many American matters. Of important national interest is "The Solution of the Cuban Problem," by the man who has been most prominently connected with the matter, Senator Platt, of Connecticut. John Kimberly Mumford, in a strikingly illustrated article, describes the Russian political advance on Asia. Theodore Waters writes of the great possibilities in transmission of electricity for power, and an article about the personality and work of Mr. Francis H. Clergue shows one example of these possibilities. Other interesting features are Sidney Brooks' third European article, this time considering Austria-Hungary; a story of the work of President Diaz, of Mexico, with prophecies as to his probable successor; the recounting of experiments made in profit-sharing, showing successes and failures with reasons; a defence of our consular service; and an account of some of the best new preventives of loss of life at sea. Then there are vivid character sketches of James J. Hill and Secretary Gage, and editorial tributes to ex-President Harrison and to General Funston. A group of three articles, "The Public Library and the Public School," "The Author and the Publisher at Peace," and "The Author as the Printer Sees Him," will have great interest for book lovers. As usual there are editorials on the March of Events, the terse book reviews, and Among the World's Workers. One great value of this magazine is that it compresses important and interesting material into short space and with clear-cut English.

MECHANICAL STUDIES.—The modern development of machinery along all branches of engineering and industrial activity calls for a continually increasing grade of intelligence on the part of the individual workman. Each year the steam shovel, the electric motor and the improved machine-shop equipment take away in part the physical burdens of the workman while they place upon him a growing load of responsibility. The man becomes less and less a mere system of muscles, and more and more an intelligent agent. The great technical schools provide admirably for the education of the designing and constructing engineer, but can make little provision whatever for the mechanic, the foreman, the practical man who remains in charge of engine and boiler rooms after the installing engineer has finished his work and the plant is in running shape. So it happens that many an important manufacturing or power plant is in the hands of employees who have little if any real knowledge of the design and construction of the machinery for which they are accountable. Such men are necessarily cheap men, for lack of the education which would give them greater wage-earning power. They are also the most expensive men, to their employers, since they lack the knowledge which would enable them to get the best results out of boiler, engine, electric generator and all the other factors in power development. To reach and educate these practical working men in ways which will add at once to their value to their employers, and hence to their wage-earning power, is the chief aim of the correspondence system of instruction. It is not suggested that this system is to take the place of a technical college education in any case where such a course is available; but to those who cannot attend technical schools this system brings the necessary practical instruction in brief, pithy lessons carefully stripped of all unnecessary theoretical details. The American School of Correspondence, of Boston, Mass., issues sets of instruction papers and books, covering thoroughly the practical details of stationary, electrical, mechanical, marine and locomotive engineering. These courses are prepared by trained instructors of the best standing and are well illustrated. By devoting the spare minutes of each working day to the successive lessons of such a course the student speedily advances until he has qualified himself for the diploma, which is given upon the satisfactory completion of the work. Whenever difficulties arise in following the work, the student writes to the instructors of the school stating the points in question, and receives prompt replies, embodying full answers to his inquiries. This system of direct, personal correspondence between teacher and pupil is continued throughout the course. There is no reason why a pupil should not receive by mail as much personal, individual attention on the part of the instructor as he would get if he were a member of a large lecture class such as is common in all technical schools. In fact, expert testimony has been given to show that a more

intimate relationship may be established between pupil and teacher under the correspondence system than could be sustained in many college classes. Many thousands of wage-earners have availed themselves of the opportunity afforded by the American School, and there is reason to believe that a system that follows so closely the needs of the workingman will have a still more rapid development in the future. The American School of Correspondence now has among its pupils a considerable number in foreign countries; Great Britain, India, Africa and New Zealand are largely represented. More significant still of the scope and standing of the school is the fact that among its pupils are a large number of graduates of the foremost colleges in the United States, who are taking this means to add to their training such lines of work as were not covered in their college work.

Record of Electrical Patents

UNITED STATES PATENTS, ISSUED APRIL 16, 1901.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

672,015. AUTOMATIC SWITCH FOR GROUPS OF TRANSFORMERS; A. Schlatter, Buda-Pesth, Austria-Hungary. App. filed Oct. 5, 1900. Details.

672,019. ELECTRIC INCANDESCENT LAMP; A. Singing-Larsen, Fredriksvaern, Norway. App. filed Oct. 2, 1899. The globe is filled with a gas that will not chemically react upon the carbon filament. The density of this gas prevents vaporization of the filament.

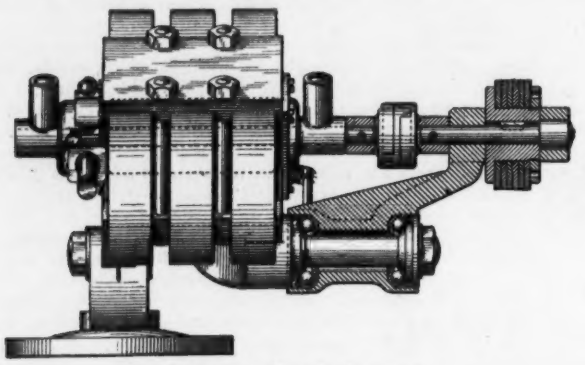
672,029. ELECTRIC GENERATOR; G. A. Burwell, Plattsburg, N. Y. App. filed Jan. 17, 1901. The invention consists in providing the armature with a flexible shaft which is constructed of two parts connected by a suitable coupling, so that the parts may move independently of each other and avoid straining and friction at the bearings.

672,032. CAR LAMP CARBON; H. A. Coughman, Burton-on-Trent, Eng. App. filed March 7, 1900. The carbon has a core composed of two parts of refractive material and one part of fluxing material.

672,047. ELECTRODE; H. E. Waite, New York, N. Y. App. filed Feb. 16, 1901. The electrode is provided with a receptacle and a passage, for a material having medicinal properties, which is administered as a spray simultaneously with the current.

672,048. STATIC MACHINE; H. E. Waite, New York, N. Y. App. filed March 8, 1901. The plates of an influence machine are clamped together at the hub by cushioning clamps.

672,064. TELEPHONE METERING SYSTEM; N. H. Holland, Brookline, Mass. App. filed Nov. 27, 1899. A signal sending device, a timing device adapted to be set in operation thereby and to continue in operation a predetermined length of time after the initial impulse which has set it in operation; and a meter controlling device operated jointly by said timing device and the device which places the telephone instrument in condition for use.



672,029.—Electric Generator.

672,071. FIREPROOF INSULATING DUCT; H. N. Speer and E. D. Speer, New York, N. Y. App. filed Sept. 8, 1900. A fireproof insulating-duct consisting of a plurality of layers of fabric saturated with a fireproofing solution, a layer of waterproofing material between the layers of fabric, and a waterproof coating outside of all.

672,074. APPARATUS FOR ELECTRICAL LAUNDERING; George D. Burton, of Boston, Mass. App. filed June 27, 1898. Electrical currents are passed through a saponaceous fluid for cleansing clothing, yarns, etc.

672,122. APPLIANCE FOR TELEPHONE SWITCHBOARDS; W. W. Dean, Chicago, Ill. App. filed Dec. 8, 1899. A device whereby calling current once applied to a subscriber's line, will be maintained in the circuit until the subscriber answers.

672,141. RAIL BOND; C. B. Thwing and C. G. Wiborg, Galesburg, Ill. App. filed Nov. 10, 1900. The bond is applied between the rail and the fish plate.

672,168. TELEGRAPH SOUNDER; W. A. Hudson, Washington, D. C. App. filed Dec. 29, 1900. The contact tip on the armature lever strikes over an aperture in the sounding post.

672,191. VOLTAIC CELL; W. H. Lawrence, Cleveland, Ohio. App. filed Oct. 9, 1897. Details.

672,195. AUTOMATIC CURRENT INTERRUPTER; H. Shoemaker, Philadelphia, Pa. App. filed Nov. 28, 1900. A separate motor is arranged to interrupt the current of an induction coil, instead of using an armature acted upon by the induction coil itself.

672,201. CARBON SORTING MACHINE; M. M. Zellers, Cleveland, Ohio. App. filed Sept. 5, 1899. A machine adapted to separate the crooked from the straight carbon pencils.

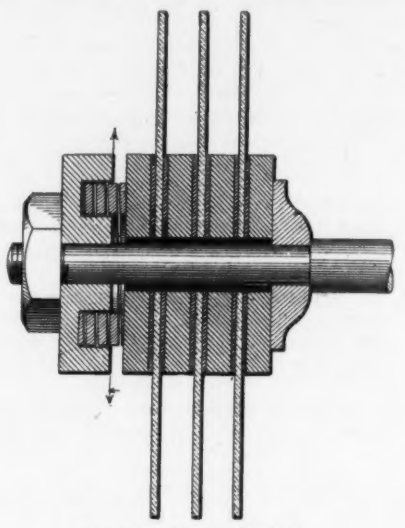
672,209. ASSORTING MACHINE; J. B. Eberling, Cleveland, Ohio. App. filed Jan. 23, 1899. A machine similar to the preceding, in which the straightness or crookedness of the carbon will predetermine its distribution, by automatically opening traps or gates placed along a track along which the carbons are carried.

672,229-30-31. APPARATUS FOR PURIFICATION OF WATER; Jean M. A. Lacomme, of Brooklyn, N. Y. App. filed July 13, Oct. 24 and Dec. 7, 1900. Electrodes are arranged in perforated non-conducting tubes supplied with contact points having at the bottom an incandescent lamp. The lamp increases the temperature and sparks are sent between the points and electrode. In another patent the sparking points are located on a rotating wheel, and in a third the sparking is between points on rod electrodes.

672,232. CONSTRUCTION OF ARMATURES AND INDUCTORS FOR DYNAMO ELECTRIC MACHINES OR MOTORS; O. Lasche, Berlin, Germany. App. filed Feb. 4, 1901. (See Current News and Notes.)

672,236. ELECTRICAL RESISTANCE WITH SMALL HEATING CAPACITY; K. Ochs, Berlin, Germany. App. filed Sept. 16, 1899. (See Current News and Notes.)

672,266. ELECTRIC FIRE ALARM SYSTEM; F. Gardner, Chicago, Ill. App. filed July 28, 1900. In an automatic sprinkling system a coil of naked wire is run through the piping, being normally held out of contact therewith by paraffin or similar material. The heat from the fire will melt the paraffin and allow contact between the wire and pipe to send in an alarm and operate the sprinklers.



672,048.—Static Machine.

672,309. PROCESS OF LOCATING METALLIC MINERALS; F. H. Brown, Los Angeles, Calif. App. filed Sept. 19, 1900. (See Current News and Notes.)

672,319. INSULATOR FOR CONDUIT ELECTRIC RAILWAYS; J. M. Eadie, A. Stevens and R. P. Tomassek, New York, N. Y. App. filed Aug. 2, 1900. A hanger adapted at one end to carry the line conductor, insulating material arranged to envelope and hold the opposite end of the hanger and means for supporting and securely holding the insulating material on its top and bottom only, free and clear of the walls of the conduit.

672,327. SWITCH FOR TELEPHONE EXCHANGES; F. A. Lundquist, Chicago, Ill. App. filed Jan. 22, 1900. Improvements in the switching mechanism which will make the automatic operation more certain.

672,335. TROLLEY POLE ATTACHMENT; W. P. Smith, Brooklyn, N. Y. App. filed Feb. 20, 1901. Rollers are arranged transversly near the rim of the trolley wheel so as to catch the wire in case it leaves the wheel. These rollers are in the circuit, and thus maintain the continuity thereof.

672,368. JUNCTION BOX; G. L. Holshuh, Brooklyn, N. Y. App. filed Jan. 23, 1901. The box is provided with an opening and devices by which it can be easily attached to a gas pipe.

672,387. ELECTRICAL CONNECTOR; T. J. McTighe, New York, N. Y. App. filed Feb. 6, 1901. This is a bond composed of a number of strands of wire with its ends welded into a homogeneous mass.

672,388. HOLDER FOR TELEPHONE RECEIVERS; C. H. Newhall, Philadelphia, Pa. App. filed Jan. 14, 1901. A bracket for the receiver, to be attached to a desk set.

672,406. COMBINED DESK TELEPHONE AND SWITCH STAND FOR INTERCONNECTING TELEPHONE LINES; H. Herbstritt, San Francisco, Cal. App. filed Feb. 12, 1900. The switch is operated by a slide working in a slot in the standard supporting the instruments.

672,419. MEANS FOR CONTROLLING ELECTRIC MOTORS; Frederic Ayres Johnson, of Binghamton, N. Y. App. filed Jan. 16, 1901. Field core pieces have a cylindrical cavity containing a plug which can be adjusted in position to vary character of field.

THE FAMOUS
ARC LAMP,
"Stellare"
TURNS
NIGHT INTO DAY!
Burns Brilliantly on a Small Consumption of Current
NEAT AND ATTRACTIVE IN APPEARANCE, ECONOMICAL, DURABLE AND SELLS AT A REASONABLE PRICE.
Descriptive matter and price list on request.
John A. Hamblin,
Providence, R. I.

NORTHWEST FIXTURE COMPANY
313 First Avenue So.
SEATTLE, WASHINGTON
IMPORTERS AND EXPORTERS
of Electrical Machinery and Supplies; Electric, Gas and Combination Fixtures and Shades, foreign and domestic

Shade Holders,
Cluster Balls,
House Goods,
Batteries,
Torches,

Dynamos,
Motors,
Arc Lamps,
Sockets,
Receptacles,
Gas Lamps.

Write for Catalogue. Lieber's Code used.

NEW YORK OFFICE
26 Cortlandt St.
NORTHWEST FIXTURE COMPANY

"Manhattan"

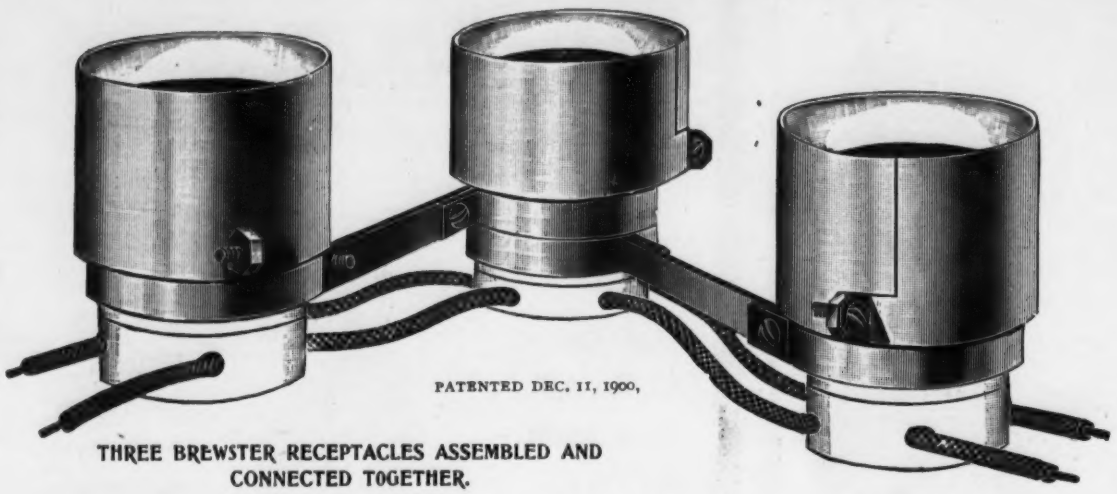
STAMPED ON AN ENCLOSED ARC LAMP
...REPRESENTS...

Latest Development
Highest Efficiency
Unequaled Quality

Manufactured for Direct and Alternating Current
Series and Multiple

Manhattan General Construction Co.
Sales Office, 11 Broadway, New York. Newark, N. J.

BREWSTER UNIVERSAL SIGN RECEPTACLES



PATENTED DEC. 11, 1900.

THREE BREWSTER RECEPTACLES ASSEMBLED AND CONNECTED TOGETHER.

A System of Units

From which may be quickly formed, wired and installed, anything in the shape of

Thoroughly Weatherproof Electric Signs,

OR

Electrical Decorations

OF ANY STYLE OR VARIETY.

Illustrating method of use, and simplicity of means by which a perfectly rigid, yet readily adjustable construction in any form or design desired is provided.

When through using the Receptacles in the shape of one Sign or Decoration, a very little labor only is necessary to make them up into something else—something entirely different.

"THE CONNECTING LINK."

JUST THE THING FOR THEATRES, OR FOR MERCHANTS WHO WANT TO KEEP ABREAST OF THE TIMES, BY ELECTRICAL ADVERTISING, AND YET REQUIRE VARIETY.

THE ELECTRIC MOTOR & EQUIPMENT CO.

12-14 BEAVER STREET, NEWARK, N. J.
Sole Manufacturers and Sales Agents.

Empire Electrical Instruments

The Most Reliable Instruments Made

Accuracy
Permanency
Durability

Portable Volt and Ammeter

A High Grade Instrument at Low Price

WRITE FOR CATALOGUE AND PRICES

Empire Electrical Instrument Co.

654 HUDSON STREET, NEW YORK CITY, N. Y., U. S. A.

WESTERN AGENTS—J. B. McKeague Co., 324 Dearborn St., Chicago, Ills.

ELECTRICITY MADE EASY

BY SIMPLE LANGUAGE AND COPIOUS ILLUSTRATION.

By EDWIN J. HOUSTON, Ph.D., and A. E. KENNELLY, Sc.D.

CONTENTS.

CHAPTER I.—The Turning of an Electric Lamp in the House. II.—How the Electric Wires are Distributed Through the House. III.—How the Electric Street Mains Supply the House. IV.—How the Street Mains are Supplied with Electricity. V.—The Electric Lighting Station. VI.—How the Incandescent Lamp Operates. VII.—How the Incandescent Lamp is Made. VIII.—How the Electric Current Supplied to the House is Measured. IX.—How the Arc Lamp Operates. X.—How the Light of Electric Lamps is Best Distributed. XI.—The Voltaic Cell and How it Operates. XII.—The Electric Bell and How it Operates. XIII.—The Electric Telegraph and How it Operates. XIV.—How the Dynamo Operates. XV.—How the Electric Motor Operates. XVI.—The Telephone and How it Operates.—XVII.—Some Other Applications of Electricity.

Cloth. 348 Pages, 207 Illustrations. Price, $1.25.

The authors have taken great pains to tell the story of electricity in a clear, comprehensive style so that beginners and laymen cannot fail to follow understandingly the text. Many analogies are given which simplify what is usually a difficult technical subject, and the book is entirely devoid of mathematics. Everyday operations in connection with electrical apparatus, usually performed in a mechanical and wholly unknowing spirit, are fully and clearly explained.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

ELECTRICAL WORLD AND ENGINEER, Publishers,

120 Liberty Street, New York.

The United States Carbon Co.

MANUFACTURERS OF CARBONS

FOR

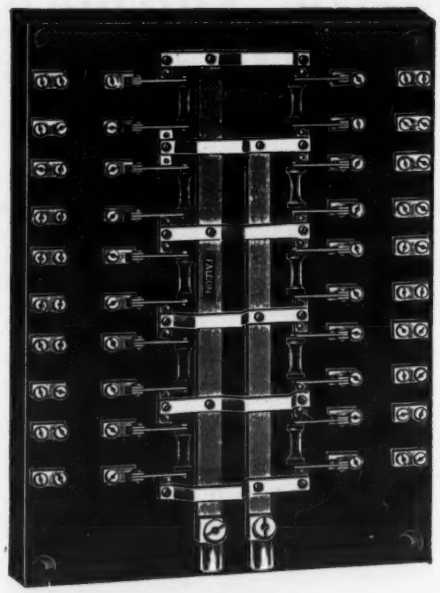
High-tension Open Arc Lamps | **Enclosed Arc Lamps**

PLAIN, COPPER-COATED AND CORED | DIRECT, ALTERNATING AND SERIES

Highest Quality **Longest Life** **Lowest Price**

CLEVELAND, OHIO, U. S. A.

"FALCON" All Copper Panel Boards



No. 222

PROMPT SHIPMENTS FROM STOCK

Write for Illustrated Bulletins and Pamphlets Nos. 1, 4, 5, 7, 8, 9, 10, 11, 12 and 18

The Falcon Electric Manufacturing Co.

General Offices and Works: 432-436 EAST 71st STREET

Sales Department: 232-234 GREENWICH STREET

NEW YORK

WESTERN SELLING AGENTS,

CENTRAL ELECTRIC COMPANY,

264-270 FIFTH AVENUE, CHICAGO, ILL.

Electric Arc Lighting

BY

EDWIN J. HOUSTON, Ph.D., and A. E. KENNELLY, Sc.D.

(Electro-Technical Series.)

CONTENTS

CHAPTER I.—Early History of Arc Lighting. II.—The Voltaic Arc. III.—Elementary Electrical Principles. IV.—Arc Lamp Mechanism. V.—Series-Connected All-Night Lamps. VI.—Constant Potential Lamps. VII.—Appurtenances and Mechanical Details of Arc Lamps. VIII.—Alternating-Current Arc Lamps. IX.—Light and Illumination. X.—Projector Arc Lamps. XI.—Arc-Light Carbons. XII.—Dynamos.

Cloth. 383 Pages. 185 Illustrations. Price, $1.00

The long-felt want for a commercial outdoor illuminant has, as is well known, been met in the now generally adopted system of electric arc lighting. The almost universal adoption of arc lighting for the streets of our large cities has naturally enough created a desire on the part of the public to understand more fully the general methods employed for the production and distribution of the electric current and the mechanism employed on the lamps for maintaining the arc and insuring a steady and reliable illumination. This work contains a brief history of the early art of electric lighting, a description of arc light generators, the various circuits employed, the manufacture of the carbon electrodes, together with a description of the lamp mechanism. The lines on which the present book has been written do not require a previous knowledge of the principles of electricity for its comprehension.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

ELECTRICAL WORLD AND ENGINEER, Publishers

120 Liberty Street, New York

RECENT TYPES OF DYNAMO-ELECTRIC MACHINERY

By EDWIN J. HOUSTON, Ph.D., and A. E. KENNELLY, Sc.D.

Profusely Illustrated with over 600 Magnificent Engravings by the best known Process, shown in Color, including Tables of exceptional Value.

CONTENTS.

CHAPTER I.—Introduction. II.—Direct-Driven Continuous Current Generators for Isolated Plants. III.—Belt-Driven Continuous Current Generators for Isolated Plants. IV.—Continuous Current Central Station Generators. V.—Central Station Arc Light Generators. VI.—Some Miscellaneous Types of Continuous Current Generators. VII.—Alternating Current Generators. VIII.—Multiphase Alternators. IX.—Alternating Current Transformers. X.—Continuous Current Motors. XI.—Locomotors. XII.—Alternating Current Motors. XIII.—Regulators for Alternating Current Circuits. XIV.—Secondary Generators.

Cloth. 612 Pages, 435 Illustrations. Price, $4.00.

Although many books have been written on the subject of dynamo-electric machinery, yet, so far as the authors are aware, none have yet appeared that have been devoted *entirely to American types of machines;* or, at least, none in which these have been treated from an entirely practical standpoint, with copious illustrations, enabling the reader to form precise ideas concerning the exact appearance, function and behavior of American machines. The book is not a treatise concerning the principles of dynamo-electric machinery, or the theory of its operation, but a descriptive treatise of the various types of machines made by different manufacturers, with their sizes, data, functions and capabilities.

In describing the various machines, attention has particularly been given to the practical rather than to the theoretical side of the subject. For this reason the book is readily capable of comprehension by those who have not had collegiate training, and is not limited, as many books on dynamo-electric machinery necessarily are, to those skilled in electro-technics.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

ELECTRICAL WORLD AND ENGINEER, Publishers,

120 Liberty Street, New York.

Algebra Made Easy

BY

EDWIN J. HOUSTON, Ph. D., and A. E. KENNELLY, Sc. D.

CONTENTS

CHAPTER I.—Introduction. II.—The Symbols Commonly Employed in Algebra with Their Meanings. III.—Powers and Roots. IV.—Radicals. V.—Logarithms. VI.—Trigonometry. VII.—Differential Calculus. VIII.—Integral Calculus.

Cloth. 101 pages with Diagrams, 75 Cents

This work is of great value to all students, but particularly to the students and laymen who are deterred by mathematical formulæ from reading otherwise intelligible scientific works.

The book is specially designed for the beginner, and for all who have not been able to avail themselves of a college education.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

ELECTRICAL WORLD AND ENGINEER, Publishers

120 Liberty Street, New York

THE INTERPRETATION OF MATHEMATICAL FORMULAE

By EDWIN J. HOUSTON, Ph. D., and A. E. KENNELLY, Sc. D.

CONTENTS

CHAPTER I.—Addition. II.—Subtraction. III.—Multiplication. IV.—Division. V.—Involution. Powers. VI.—Evolution. Roots. VII.—Equations. VIII.—Logarithms. IX.—Trigonometry. X.—Hyberbolic Trigonometrical Functions. XI.—Differential Calculus. XII.—Integral Calculus. XIII.—Determinants. XIV.—Synopsis of Symbols.

Cloth. 225 Pages, 9 Diagrams. Price, $1.25

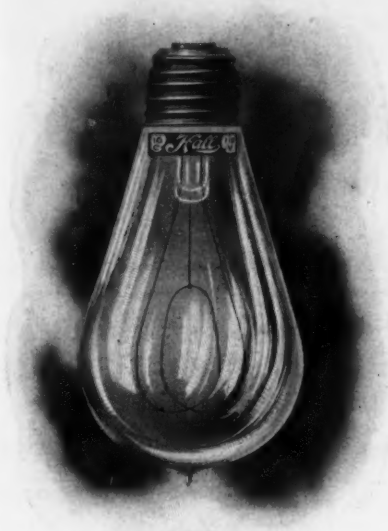
A new work for students' use and to aid all who are educating themselves in the higher mathematics. It is a thorough explanation, in perfectly simple language, of the class of formulæ used in electrical calculations. A study of this little book will enable any engineer to read understandingly the mathematical expressions found in technical books and periodicals.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

ELECTRICAL WORLD AND ENGINEER, Publishers

120 Liberty Street, New York

Western Buyers, ATTENTION!



HALL LAMPS are manufactured with the greatest care, and are guaranteed to give entire satisfaction. Quality unsurpassed, and c. p., voltage and efficiency exactly as ordered.

Prompt Shipments. Prices Right.

THE CAPITAL ELECTRIC CO., MAKERS

DENVER, COLO.

CLUSTER AND PENDANT FIXTURES

PLAIN OR ORNAMENTAL, MIRROR LINED OR OF OPAL GLASS

WHEELER REFLECTOR CO.

100 PURCHASE STREET BOSTON, MASS.

"BY EVERY TEST THE BEST"

Constant Potential
3 to 5 Amperes

Constant Current Series
5 to 7 Amperes

Alternating Current
4 and 6 Amperes

Our Catalogue gives full description

STERLING ARC LAMP CO.

214-222 West 26th St., New York

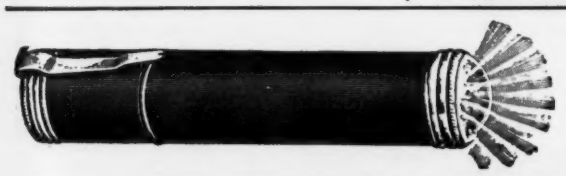
You can reach everyone in the electrical field whose attention it is possible to secure through a newspaper by advertising in ELECTRICAL WORLD AND ENGINEER.

"FEMCO" INCANDESCENT LAMPS

Economical in Consumption of Current; High Average of Candle Power; Thoroughly Tested at Factory; Fully Guaranteed.

FRANKLIN ELEC. MFG. CO. HARTFORD CONN., U. S. A.

(4)



THE IMPROVED YANKEE SEARCHLIGHT

OPERATED BY DRY CELLS THAT DO NOT DETERIORATE UNLESS USED

PRICE EACH, $2.00

STROBEL & WILKEN CO. - - 591 Broadway, New York

FOR ENCLOSED LONG-BURNING ARC LAMPS.

ELECTRA TRADE MARK

"ELECTRA"

ELECTRA TRADE MARK

FOR DIRECT CURRENT ARC-LAMPS

FOR ALTERNATING CURRENT ARC-LAMPS

ELECTRA ELECTRA

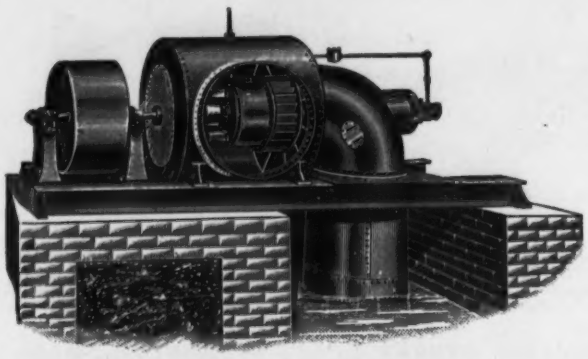
HIGHEST GRADE NUERNBERG CARBONS

UNEQUALLED IN QUALITY AND EFFICIENCY

ABSOLUTELY STEADY AND BRILLIANT LIGHT.

HUGO REISINGER, 11 Broadway, New York.

THE NEW AMERICAN TURBINE



FOR

Electric Power Transmission

STATE YOUR REQUIREMENTS AND SEND FOR CATALOGUE

THE **DAYTON GLOBE IRON WORKS CO.**

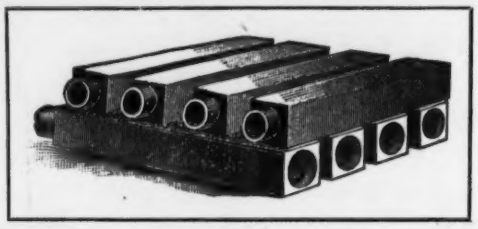
90 S. Ludlow Street,

DAYTON, OHIO, U. S. A.

CREOSOTED WOODEN CONDUIT

The most practical, durable and economical of any conduit on the market.

UNDER CHESNUT PATENT



OVER 500 MILES OF THIS CONDUIT NOW IN USE IN THE CITY OF PHILADELPHIA

N. B. BUBB, Manager J. M. CHESNUT, Supt.

WILLIAMSPORT WOODEN PIPE CO.

WILLIAMSPORT, PA.

WRITE FOR INFORMATION AND SAVE MONEY

ELECTROLYSIS PROOF

Underground and Interior Guaranteed to Stand 50,000 Volts

ASPHALT PAPER CONDUIT

An absolute non-conductor. Guarantees perfect insulation. Better service obtained over wires enclosed in it. INDESTRUCTIBLE. Water and dampness causes it to become hard as iron. Cheapest of conduits to lay, using ordinary labor. Cheapest to ship.

GUARANTEED ABSOLUTELY ELECTROLYSIS PROOF.

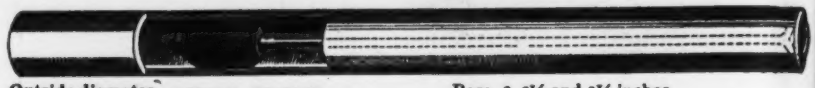
Seven-foot lengths, 3 and 3¼-in. bore; weight, 2 lbs. to foot. Made in desired sizes from 2" to 8". Price, F. O. B. destination, cheapest of any conduit on market. Prices for high voltage conduit upon application.

For prompt delivery for 1901 orders should be placed at once.

ELECTROLYSIS PROOF CONDUIT MFG. CO.
605 Manhattan Bldg., Chicago, Ill.

STONE CONDUIT

15 TO 20 PER CENT. LESS THAN TILE CONSTRUCTION



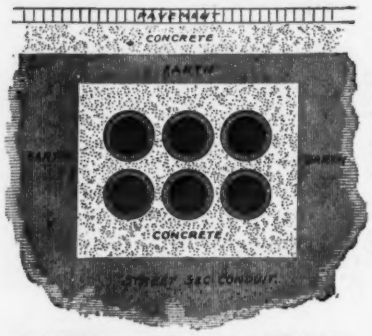
Outside diameter, 4¼ inches. *PATENTS PENDING.* Bore, 3, 3⅛ and 3¼ inches. Length, 6 feet.

Pipe are easily sawed to any desired length or angle.

NO INSPECTION OF PIPE REQUIRED All Pipe are Perfect WE STAND LOSS BY BREAKAGE

PORTLAND CEMENT and *CRUSHED STONE* are the only materials entering into the construction of our

UNDERGROUND SUBWAY SYSTEM



INDESTRUCTIBLE

A SOLID BLOCK OF STONE WITHOUT JOINTS, AND A GOOD NON-CONDUCTOR

EVERLASTING

CONSTRUCTION IS VERY RAPID, USING ONLY ORDINARY LABOR IN THE ENTIRE WORK

WATER AND GAS-PROOF

It is the strongest of CONDUIT STRUCTURES, as the concrete unites with the exterior of the pipe.

Pipe are manufactured by a new process of subjecting the material to an IMMENSE PRESSURE from the INTERIOR of the pipe which gives a bore of PERFECT DIAMETER and POLISHED SMOOTHNESS, the whole having a uniform strength and density. Such pipe when laid in concrete with our RUBBER MANDREL, under EXPANSION, have perfect ALIGNMENT without chance of error in construction.

We build complete underground subway systems.

AMERICAN STONE CONDUIT CO.

WEST EIGHTEENTH AND SOUTH LINCOLN STREETS

CHICAGO, ILLINOIS, U. S. A.

WRITE FOR SAMPLE OR OTHER INFORMATION

Richmondt Electric Wire Conduit Company

MILWAUKEE, WIS., U. S. A.

ELECTRO GALVANIZED EXTERIOR AND FLEXIBLE ENAMELED INTERIOR ON REAMED STEEL TUBING.
Patented March, 1900.

CONDUIT TUBING.

This pipe fills all of the requirements of and is approved by the National Board of Fire Underwriters.

NEW YORK AND MAIN EASTERN OFFICE: W. S. BROWN, 39-41 Cortlandt St.

SAN FRANCISCO, Wybro-Hendy Co., 38-44 Tremont St.
CHICAGO, Electric Appliance Co., 92 and 94 West Van Buren St.
BOSTON, Chase-Shawmut Co., 390 Atlantic Ave.
BUFFALO, Albert Mann, Mooney-Brisbane Bldg.
SEATTLE, WASH., Northwest Fixture Co.,
PHILADELPHIA, J. F. Buchanan & Co., 40 North Fourth St.
BUTTE, MONT., Montana Electric Co.
MINNEAPOLIS, MINN., B. B. Downs, 2623 First Ave.
MONTREAL, R. E. T. Pringle, 216 St. James St.
ST. CATHARINES, ONT., Packard Electric Co.

SMITH-VAILE ELECTRIC PUMPING MACHINERY

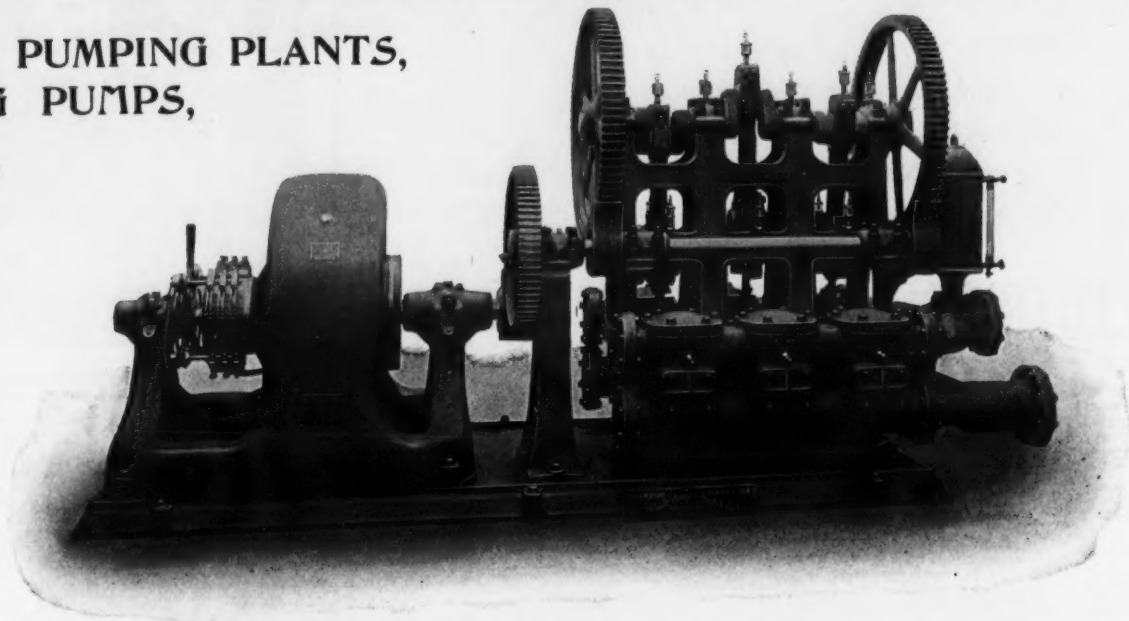
FOR PUBLIC BUILDINGS, OFFICE BUILDINGS, APARTMENT HOUSES, ETC.

WATER WORKS PUMPING PLANTS,
MINING PUMPS,

STEAM AND POWER
PUMPING MACHINERY
FOR EVERY PURPOSE

Jet and Surface CONDENSERS,
AIR COMPRESSORS, FEED
WATER HEATERS.

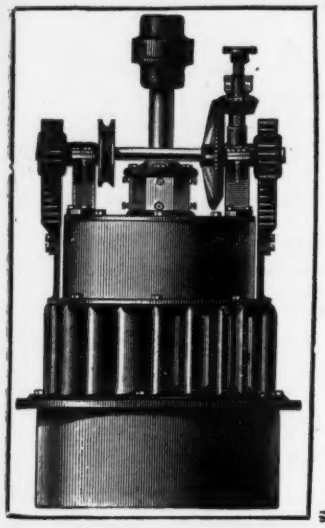
Our Catalogues are free.



The Stilwell-Bierce & Smith-Vaile Co.

262 Lehman St., DAYTON, OHIO, U. S. A.

CHICAGO: 311 Dearborn St.
NEW YORK: 141 Broadway.
BOSTON: 73 Oliver St.
PHILADELPHIA: 612 Arch St.
CLEVELAND: 19 S. Water St.
PITTSBURG: Smith Block.
NEW ORLEANS: 304 Hennen Bldg.
LONDON: E. C., 97 Queen Victoria St.



THE McCORMICK TURBINE.

Features

Worth Consideration:
Great Capacity, High Speed, Unequalled Efficiency,
Steady Motion, Easy Working Gate,
Greatest Power from a Limited Quantity of Water, at Smallest Cost.

UNDOUBTEDLY THE MOST POPULAR TURBINE MANUFACTURED.

S. MORGAN SMITH COMPANY,
YORK, PA., U. S. A.

WRITE FOR CATALOGUE.

CARY SPRING WORKS

240 and 242 West 29th St., New York City
Manufacturers of
WIRE and SPRINGS
OF ALL KINDS
Telephone 3346 38th St.

WE PUBLISH
WE SELL **BOOKS** on all Electrical Subjects

Write for Catalogue. ELECTRICAL WORLD AND ENGINEER, 120 Liberty St., New York

Emerson 1901 Catalogue

Of Fan Motors will be sent on request. Several new types described. Send for a copy.

Eastern Office and Warehouse,
136 Liberty St.,
New York City.

THE EMERSON ELECTRIC MFG. CO.
St. Louis, Mo., U. S. A.

The first and most important point about advertising is to select the right medium. If you want to do business with any man in the electrical field in any part of the world, the right medium to advertise in is ELECTRICAL WORLD AND ENGINEER.

SAMSON TURBINE

UPRIGHT AND HORIZONTAL
FOR
ELECTRIC POWER and LIGHTING PLANTS.

SPECIAL FEATURES:

High Speed and Efficiency. Great Strength. Balanced Gate. Close Regulation and Steady Motion. Great Power in limited penstock room. Special attention given to designing for difficult situations. Write for pamphlet I, stating your Head and Power required.

JAMES LEFFEL & CO., Springfield, Ohio, U. S. A.

THE PELTON WATER WHEEL COMPANY

gives exclusive attention to the development and utilization of water powers by the most modern, economic and improved methods.

An experience of more than fifteen years, involving both the theory and practice of hydraulic engineering as relates to power development in its widest range of application, is at the service of its customers. **NINE THOUSAND WHEELS NOW RUNNING,** aggregating some 700,000 H. P.

ELECTRIC POWER TRANSMISSION.

Pelton Wheels afford the most reliable and efficient power for such service, and are running the majority of stations of this character in the United States, as well as most foreign countries.

Highest efficiency and absolute regulation guaranteed under the most extreme variations of load. Catalogues furnished on application. Address

PELTON WATER WHEEL COMPANY,

121 Main Street,
San Francisco, Cal., U. S. A.

143 Liberty Street,
New York City, U. S. A.

This IS an Advertisement

We wish to call your attention to the Gutmann Integrating Wattmeter for alternating current.

It is the best Wattmeter made. Thousands are being sold. You will adopt it when you have tried one. Write us or send trial order.

ELECTRIC APPLIANCE COMPANY

92 and 94 West Van Buren Street, Chicago

GENERAL ELECTRIC COMPANY'S....

Candelabra, Series, Decorative, Battery and **Miniature Lamps** are made of the best quality of materials, with superior workmanship, and show constant improvement in detail.

SEND FOR CATALOGUE 9050.

EDISON DECORATIVE AND MINIATURE LAMP DEPARTMENT,

(4) HARRISON, N. J.

P&B INSULATION

P. & B.

Electrical Compound

Contains no tar or oil. Proof against water, acids, alkalies, gases, etc. Penetrating, tenacious and elastic, durable. Unequaled for underground, submarine or exposed insulation. 14 years of expert commendation.

The Standard Paint Company

100 WILLIAM STREET, NEW YORK

National Electrical Code Standard

WEATHER-PROOF TRADE MARK "O.K." LINE AND HOUSE WIRES

"O. K." WEATHERPROOF, SLOW BURNING WEATHERPROOF, AND SLOW BURNING WIRE.

PRICES AND SAMPLES ON APPLICATION.

PHILLIPS INSULATED WIRE CO.,

OFFICE AND FACTORY, PAWTUCKET, R. I.

For an all over-the-world circulation of the right kind there is no paper published which equals the EXPORT ISSUE of ELECTRICAL WORLD and ENGINEER.

FLEXIBLE MICANITE

STYLE "C"

Our latest production in high grade Insulation, Highest Insulating Qualities. Flexible as Rubber.

MICA INSULATOR COMPANY

"ORIGINATORS"

218 Water St., NEW YORK 117 Lake St., CHICAGO

HYLO

Lamps save 5/6 of the current when turned "low" by the consumer; make 5/6 of the lamp profit when boomed "high" by the dealer. Any consumer can use them. Any dealer can sell them. A postal card will bring particulars.

THE PHELPS COMPANY

10 Hawthorne St., ELMWOOD, ILL.

NATIONAL ELECTRICAL CODE STANDARD SLOW-BURNING WEATHERPROOF

IXL WEATHERPROOF AND SLOW-BURNING WIRE

Send for samples and prices

Collyer Insulated Wire Co., Pawtucket, R. I.

Don't fail to see the McRoy Conduit Exhibit at the Buffalo Exhibition.

McROY CLAY WORKS

BRAZIL, INDIANA

302 BROADWAY, NEW YORK

138 WASHINGTON ST., CHICAGO

IN WRITING TO ADVERTISERS Subscribers will confer a favor on us and also on the advertisers by mentioning that they saw the advertisement in ELECTRICAL WORLD AND ESTABLISHED 1877 ENGINEER.

"MANROSS" HAIR SPRINGS FOR ELECTRIC INDICATING AND RECORDING GAUGES STEAM GAUGES, ETC

LARGEST MANUFACTURERS OF

Hair Springs in the United States.

Non-Magnetic Hair Springs of Phosphor-Bronze and other non-magnetic metals. Hair springs of any description manufactured to order.

F. N. MANROSS. - Forestville, Conn.

SAMSON SPOT CORD FOR...

Arc Light AND Trolley Cord.

Send for Samples and Prices.

SAMSON CORDAGE WORKS. BOSTON, MASS.

STERLING EXTRA INSULATING VARNISH.

Sterling Extra Black Finishing Varnish. Sterling Black Air Drying Varnish.

Sterling Black Core Plate Varnish

THE STERLING VARNISH CO.,

Times Building, PITTSBURGH, PA., U. S. A.

95 COLMORE ROW, BIRMINGHAM, ENGLAND.